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CERAMISTS MEET AT BUFFALO

GLASS DIVISION HEARS EXCELLENT PROGRAM OF PAPERS, VISITS PLANTS. BUFFALO SHUFFLE HIGH SPOT OF ENTERTAINMENT. OFFICERS ELECTED.

THE Buffalo meeting of the American Ceramic Society more than fulfilled expectations. The program was excellent, the attendance large, entertainment novel and colorful; in fact, from every standpoint, the meeting was one of the very best of the Society's history. A spirit of optimism was generally noticeable, reflecting no doubt the expanded scale on which many plants have been operating since the first of the year, and this feeling played its part in creating a proper convention atmosphere from the start.

The Glass Division got under way Tuesday morning and thanks to its chairman was able to complete an unusually full program practically on schedule the whole time. Both Tuesday and Wednesday's sessions were well attended, even though the glassmen were considerably outnumbered in point of attendance by the other divisions. There were seventeen papers read at this meeting, summaries of which are given in pages that follow. At the conclusion of the Glass Division meeting, Chairman Bailey was presented with a handsome Pyrex gavel, made at the Corning Glass Works. Division officers elected for the ensuing year are U. E. Bowes, chairman; Joseph Gregorius, vice chairman; and Samuel R. Scholes, secretary.

The Art Division scheduled what was by far its most ambitious program, which covered Monday afternoon and all of Tuesday. The papers and addresses covered subjects that were directly related to ceramics in general, but few of them were closely identified with glass. This Division is proving itself one of the most active in the Society, and among its projects for this year is the publication of three complete issues of *The Bulletin*.

On Wednesday afternoon the Refractories Division held a meeting jointly with the Glass Division, following a most interesting address and demonstration of Liquid Air by E. A. Harding of E. I. Du Pont.

Since the spirit of fellowship very properly plays such an important part in the success of a convention, too much praise cannot be accorded the convention committee for the success of their efforts in this direction. The great Buffalo Shuffle, shrouded deeply in mystery till the very last, set the pace from the moment the gates of Ecocas were thrown open. This thriving western mining town of the gay 60's provided thrills aplenty, with its crowded gaming tables, its dance hall and painted molls, the long mahogany bar—all done in true frontier style. However, order was maintained at all times thanks to Sheriff Lazier and his deputies. The climax of the evening was reached when Ross Purdy was presented with a commission as Colonel from the state of Kentucky, and invested with his hat, tie and (pyrex) sword.

The dinner dance on Wednesday was just a trifle too crowded, if this could be called a fault. The Carborundum Band, justly celebrated throughout Western New York, provided the music, and Mr. Bowman kept things moving in his capacity as announcer. The presence of more than the usual number of women guests contributed to the success of this evening in particular.

Favorable weather brought a big turn out for all the plant trips. On Thursday nearly everyone went to Niagara Falls, where the visit to the Carborundum Company was noteworthy. At the Falls themselves, the lecture by W. K. Bradbury on the geological aspects of Niagara was particularly interesting. Many of the Glass Division members visited the Bausch & Lomb, Eastman Kodak and Corning plants.

The annual business meeting of the Society was held following the luncheon on Wednesday. J. M. McKinley, North American Refractories, was elected president and Francis Flint, Hazel Atlas Glass Co., vice president. A new class of membership was voted for students, whose annual dues were fixed at five dollars.

On Tuesday the Edward Orton, Jr., Lecture was delivered by Dr. H. Ries of Cornell University on clay research, following which the meeting was turned over to President W. Keith McAfee for the induction of members newly elected to the A. C. S. These are: E. E. Grosinger, W. V. Knowles, D. A. Moulton, Erwin Sohn, C. R. Amberg, Donald Hagar, R. S. Bradley, F. L. Steinhoff, C. L. Thompson. Frederick H. Rhead was then awarded the Charles Fergus Binns Medal by Dean M. E. Holmes of Alfred University for his outstanding achievement in design. The meeting was closed with Memorial Services for the late charter members, Charles Fergus Binns and William Day Gates, who were eulogized by Willard D. Richardson, one of the eight remaining charter members.

SUMMARIES OF GLASS DIVISION PAPERS

1. The Calculation of Physical Properties of Glasses from their Composition

By S. R. Scholes, Department of Glass Technology, New York State College of Ceramics, Alfred, N. Y.

Dr. Scholes first reviewed briefly the "Additive Theory" of calculating the physical properties of glasses from their oxide content. He pointed out that, although this method is not strictly accurate, it has been of service in determining

SCENES AT BUFFALO WHER

1. The crowd begins to arrive for the Shuffle, the big surprise party Monday night, which was easily the high light of the entertainment program. Pictures 1 and 9 all are scenes taken at the Shuffle.

2. Entering "Ecocas," a western frontier town of yesterday.

3. The bar, where drinks cost several hundred dollars a gulp in Ecocas money.

4. Those Ecocas cowboys sure knew their music.

5. Sheriff Lazier—one tough hombre if you tried to start something.

6. These chemists sure make the money. Two hundred Ecocian dollars was the minimum bet at any of the gaming tables.

7. Deputy sheriff Don Sharp. Don't he look mean!

8. Looking down on the crowds, which pac the big ball room to overflowing. The G Industry's staff photographer (John Hostett had lost his flash lights in the excitement t night, and you've got to hand it to him a photographer.

9. Colonel Ross Purdy receives his commiss from the State of Kentucky. And didn't ceramists cheer!

10. Mr. Lark-Horovitz explaining one of Purdue formations that will be used next against Michigan.

11. At the joint session of the Refractories Glass Divisions. The distinguished look gentleman in the center foreground is S Scholes.

12-13. Glass Division sessions. Lantern sli were used even more freely than usual this ye

14. Mr. Roche watching the demonstration Liquid Air that took Mr. Taylor's breath aw

GLASSMEN MET LAST MONTH

1. Hail the new A. C. S. President! J. M. McKinley, and Dr. Hostetter just after the former's induction into office.

2. Dr. Geo. Morey—He put the Geo in the Geophysical laboratories.

3. Five out of a delegation of six from the Pittsburgh Plate Glass Company (left to right) C. Parkinson, C. S. Linder, C. E. Fulton, A. Miller and R. E. Jones. The missing member of the sextet was later located posing for picture No. 32, see below.

4. A. N. Finn, Bureau of Standards, and R. A. Hiller, Pittsburgh Plate Glass Co., enjoying a moment of relaxation after a hard day's work.

5. Doctors Tillitson and Taylor, the latter carefully guarding a copy of Glass Industry under his arm.

6. A. K. Lile and Wilbur Brown focusing on the camera. Their attempt nearly succeeded.

7. O. E. Bowes, the new chairman of the Glass Division being interviewed by a gentleman of the press regarding his plans for 1935.

8. Chairman Jim Bailey, with the Pyrex gavel presented by Corning Glass Works. Now you know why all the Glass Division meetings were conducted so efficiently.

23. Francis C. Flint, the new vice president of the American Ceramic Society. But this vice president really works.

24. Karl Ford studying the behavior of the Canis familiaris caloris. Mary Radcliffe of A. C. S. headquarters assists in the experiment.

25. Emily van Schoick, A. C. S., whose competent work behind the scenes helps to make the conventions run so smoothly.

26. R. B. Carothers and president Keith McAfee, in executive session.

27. E. O. Hiller and F. L. Lloyd in conversation with J. L. Bacon. Mr. Bacon tried to dodge the camera man just too late.

28. Otto David of O. Hommel. And just beside him (29) are Ernest Hommel and William Baldwin, the latter being the new research fellow at Mellon Institute.

30. J. L. Crawford, alias Herbert Hoover. In fact we introduced him that way once!

31. This is what happens to glass men who don't buy from O. Hommel. At least this is the bird we found in Mr. Hommel's room—and the conclusion was inescapable.

32. M. G. Babcock. We nearly missed Mr. Babcock, but as No. 17 explains, we caught him just before we turned the page.

the properties of glasses of the same general type as those from which the factors may have been derived.

These oxide factors may be criticized because: 1. they are unreal, inasmuch as they are based on oxides which for the most part are not glass-forming; 2. the glass is considered to be made up of all of these oxides in solution, each of which contributes independently to the physical properties of the glass; and 3. because the factors do not lead to true values when applied to the oxides themselves in their pure condition.

These criticisms may not apply, however, if we assume that compounds exist as such in the glass and that each contributes its own specific physical properties to the properties of the glass as a whole. We must also assume that the specific physical properties of a given glass may actually be found by an additive method from the numbers representing the separate physical properties of the individual components assumed to be present. However, if these factors are to have reality, it is important that such a group of factors be applied to the per cent by volume of the compound present rather than to the per cent by weight.

Dr. Scholes then gave the results of the recalculation, by this method, of the coefficient of expansion of a series of boric oxide soda glasses. He assumed that in any acid glass compounds of soda and boric oxide containing a minimum of soda, the compound most likely to be formed would be $Na_2O.4B_2O_3$. The soda remaining was calculated as $Na_2O.2SiO_2$ and the excess silica as SiO_2.

When these results were compared with the factors used by Winkelman and Schott, and by English and Turner, they showed excellent agreement with the measured value.

2. Viscosity and Thermal Conductivity of Soda-Potash-Silicate Glasses

By K. Lark-Horovitz and C. L. Babcock, Purdue University, Lafayette, Ind.

The viscosity and electrical conductivity of a series of glasses containing soda, potash and silica were investigated by a previously described method utilizing an apparatus that measures both of these properties simultaneously.

It was found that in glasses with an excess of potash over soda, the simple relationship between conductivity (λ) and viscosity (η) as shown by the formula, $\eta = A\,[1/\lambda]^B$, no longer holds where A equals the temperature. It was found that in this case, the temperature dependency of the work function for conductivity and viscosity is not the same. This would indicate the effect of the formation and break-up of complexes at this temperature.

3. The Hardness of Glass

By G. W. Morey, Geophysical Laboratory, Washington, D. C.

Although hardness is a term familiar to all, no satisfactory definition of it has been formulated which can be translated into measurable quantities. Auerbach showed that the scratching test of the mineralogist gave doubtful results, when he found that with a series of 14 glasses from the softest to the hardest, every glass scratched every other one. Assuming scratching hardness to be a purely emperical test, Martin devised a method for carrying out such a test under standardized conditions. Unfortunately, however, everyone who has used Martin's method has expressed his findings in a different manner, with the result that they are not comparable.

Hardness should be definable in terms of elastic moduli, Poisson's ratio and the strength of the glass, but no attempt to so define hardness has been made. To date the most fundamental discussion of hardness in terms of physical constants is that of Herz; however, Auerbach tested the work of Herz with emperical results to both.

The various methods of measuring hardness do not even arrange a series of glasses in the same order, and no method has been devised which even gives a satisfactory measurement of a quantity which might be described as hardness.

4. Modulus of Elasticity of Glass in Relation to Temperature

By A. E. Badger and W. B. Silverman, University of Illinois, Urbana, Ill.

The modulus of elasticity of the glass,

67.10 SiO_2, 2.96 Al_2O_3
0.19 Fe_2O_3, 4.15 MgO,
5.60 CaO, 20 00 alkalis,

was determined at various temperatures by measuring the elongation of a glass fiber under load. The rate of decrease of modulus with temperature showed an abrupt change between 250° and 300°C. It was considered that this phenomenon was connected with the increased rate of expansion which occurs in glasses near these temperatures.

A description is given of an interferometric method of measuring the deflection of compressed specimens at temperatures up to the softening point of the glass.

5. Lithium Oxide as a Constituent of Glasses—Its Effect on Thermal Expansion

By Louis Navias, General Electric Co., Schenectady, N. Y.

Dr. Navias first reviewed the rather scanty literature concerning glasses containing lithium and showed that Winkleman and Schott had based their calculations for the expansion factor of Li_2O on a single glass of the following composition: Li_2O, 6.0%; Al_2O_3, 30.0%; B_2O_3, 64.0%. This glass, which was remade by the author, proved to be rather poor and readily devitrified when reworked in the flame.

Winkleman and Schott's calculated factor for Li_2O obtained from this glass showed a considerable difference in the effect of lithium on the thermal expansion, as compared with the effect of soda and potash.

As a check on the validity of this factor, several borate and several silicate glasses were taken from the literature and by a comparison of their compositions and measured thermal expansions Dr. Navias showed that soda and lithia are similar in behavior in promoting high thermal expansion.

Dr. Navias also prepared a series of glasses containing lithia and soda and measured their expansions. The calculated factors for Li_2O and Na_2O in these glasses showed that lithia is as effective as soda in imparting a high thermal expansion to glasses containing these oxides.

6. Progress Report on the Development of Methods for the Determination of the Chemical Durability of Glass

By G. E. F. Lundell, National Bureau of Standards, Washington, D. C.

Dr. Lundell reported on the first results obtained by the various cooperators using Method No. 1 on the No. 1 glass. Results were also given of the second trial by a selected number of cooperators on both the No. 1 glass and a sample of sheet glass. A discussion of the test method, the results and certain modifications was also presented.

Due to the importance of this paper it has not been abstracted but will be published in full in a later edition of The Glass Industry.

7. Relation of Electrical Surface Resistance of Glass to Chemical Durability

By E. M. Guyer, Corning Glass Works, Corning, N. Y.

A short review of electrical conductors and the effect of surface leakage of glass insulators was given in addition to a brief description of the method used in measuring surface resistance. Surface resistance measurements on a graded soda-lime-silica series of glasses and on a mixed series including borosilicates, lead glasses, lead borosilicates, and lime glasses were made and the results compared with measurements of loss of weight in water vapor made on the same glasses.

The changes in surface resistance proved to be a good measure of surface alkali.

A weathered piece of window glass was measured first as received, water washed, acid washed and finally with the original surface film removed by grinding and polishing. The changes in surface resistance after each treatment was shown graphically.

8. Some Observations on the Action of Steam on Glass

By O. G. Burch, Owens-Illinois Glass Co., Alton, Ill.

This paper gives the results of a series of tests of the action of both wet and dry steam under various conditions on various types of bottles (ordinary soda-lime-silica glasses).

The method of test was in general as follows: The autoclave was filled with the required amount of water, the bottles placed in an inverted position in a special tray and placed in the autoclave. With the top of the autoclave open heat was applied until the boiling point was reached. The top was then closed and with the autoclave valve open the pressure was allowed to build up to approximately 3 pounds pressure. The valve was then closed and the pressure allowed to build up to the required pressure. The usual

(*Continued on page* 91)

Furnace, feeders and bottle forming machines at Glass Containers, Inc., Los Angeles.

HOW MECHANICAL BATCH HANDLING PAYS PROFITS TO GLASS CONTAINERS, INC.

MODERN industrial or manufacturing plants of any importance, regardless of their products, are very similar in plant design. All plant designers are striving toward straight line production, simplicity of plan, economy of space, and modern labor saving equipment. They all are pointing toward the same objective, the most economical method of converting a raw product into a finished one.

Too often the blame for an uneconomical plant can be laid to the fact that designers, operators, or both, were versed in manufacturing only in one particular line, and were without the benefit of the knowledge obtained by broader experience in general good factory practice.

The operations in a glass containers plant, with the possible exception of forming, are analogous to the operations of many other industrial plants. For instance, batch material handling has been brought close to an exact science by concerns handling almost the same materials for other purposes. Moreover, sorting and packing have been brought to a high state of efficiency through being important to many industrial processes.

The erection of the new plant for Glass Containers, Inc., in Los Angeles, California, was the result of application of the above principles; the objective, as set forth by the Architect, John M. Cooper of Los Angeles, having been to incorporate the following features in its construction:

1. The batch handling plant must be a one man plant; that is, as nearly automatic as possible and operated from one central point.
2. That all sand must be handled wet.
3. Automatic, highly adjustable, feeding of the batch to the furnace.
4. Batch handling equipment of ample capacity, of such quality as to insure long life, as noiseless and dust proof as possible, and which would assure of no demixing.
5. A plant which at a very small cost could be expanded to three times its original capacity, and which, when expanded, could handle two grades of sand and three or more kinds of cullet.
6. Labor saving sorting and packing equipment at the discharge end of the lehrs.
7. Automatic, recorded weighing of batch materials.
8. A minimum, set cost per ton for handling all batch materials from the cars to the tank.

The sand and other materials are unloaded from the cars by electric conveyors. The sand is stored in a thousand ton, covered, concrete sand bin and the other materials are elevated by a bucket elevator to tall vertical concrete bins, of 350 tons capacity, similar in form to grain silos. They are all then conveyed electrically and by gravity to a scale hopper in the batch room where they are weighed (the weights electrically recorded), and the entire batch discharged by gravity into a mixer. The unit empties automatically onto a conveyor which carries the mixed batch to a bucket elevator. It lifts the batch up to the mixed-batch bins, each of 35 tons capacity, located directly over the dog house floors. From these bins the batch flows by gravity to the automatic feeders, and by them is fed into the furnace.

Since the sand is wet and cannot flow by gravity, it is taken by a drag line scraper from any part of the sand bin to a hopper adjacent to the batch room, and from here it goes by conveyor and elevator to a surge hopper over the scale hopper.

The cullet is crushed in the basement under the batch room, is stored there in bins, and fed into the crusher by conveyor. The crusher is provided with a magnetic metal separator, and discharges into the main elevator, which lifts the cullet to the top of the tall storage bins. From this point the cullet flows by gravity from the bins to the weigh hopper.

Economy of operation and low initial cost of conveying machinery was obtained by operating the batch plant from a central point, using a judicious location of the plant with respect to the railroad spur, and by being very frugal with the amount of ground space used in storing the materials.

In the batch room the materials are weighed accurately and the weights electrically recorded.

With the exception of sand, all the materials required for a daily capacity of 150 tons can be stored in a ground space of less than 600 square feet. This is accomplished by utilizing a basement under, and high bins over, the batch room. As the sand bins are adjacent to the batch room, the handling of the sand is done at the batch room end of the sand bin by the single operator of the batch room. The use of a tall, slender storage arrangement allows the utilization of gravity conveying, and does away with such supernumerary appendages as weigh cars, trackage, etc. The weighing is done with electrical recording dial scales, giving an itemized, printed record of each weigh.

To convey the materials from the centrally located batch room to the tanks, and still keep the one man plant goal, it was necessary:

1. To have a mixer that would operate entirely without the aid of an operator. The ordinary concrete type of mixer requiring a varying amount of labor in feeding and discharging could not be used. The mixer used in the Glass Containers' plant has a power screw feed, and after mixing it has a positive, automatic discharge, at a speed that will not choke the conveyor onto which it feeds. It is started by push button, and stops automatically immediately after the batch is discharged. It is practically dust proof.

2. The feeders to the tank must not only be automatic but adjustable to give a feed volume to take care of any ware from one ounce to the largest container ever made. Although operated by identical motors, they really are two separate units, each with numerous adjustments. The feeder proper in this case is based on the principle of the reciprocating plate feeder. This arrangement gives continuous, regulated flow of batch to the dog houses. The batch is pushed into the furnace by a mechanical hoe, the operation of which was planned to duplicate the age old manual hoe operation as nearly as possible. It is provided with several adjustments to suit the amount, etc., of the material being melted at the time. Its use accomplishes a very slow, continuous, steady stream of perfectly mixed batch flowing in at each of the dog houses of each furnace.

This spacious warehouse accommodates the packed ware until it is moved out by electric mules to the freight cars.

The only manual labor required in the operation of the batch plant is the operation of the drag line sand scraper hoist levers every sixth batch, the working of the levers of the gates to the material chutes, and the dumping of a can of color ingredients into each batch. The average batch comprises 1600 pounds of materials.

The materials stored in the tall concrete tanks are distributed at the top of the tanks by means of a swing spout. The particular bin opening over which it is desired to place the spout is indicated in the batch room on a dial. The spout is placed over this opening by means of a winch and cables, and a pointer on the dial. This swing spout and all bin openings are covered with a corrugated iron pent house to keep out the moisture and keep in the dust.

The mixed batch bins, one for each furnace, are of 35 tons capacity each, to allow for shut downs for repairs or for switching from one color of batch to another.

Placing the cullet basement directly under the batch room made possible the use of a single bucket elevator to carry all materials, including the cullet itself.

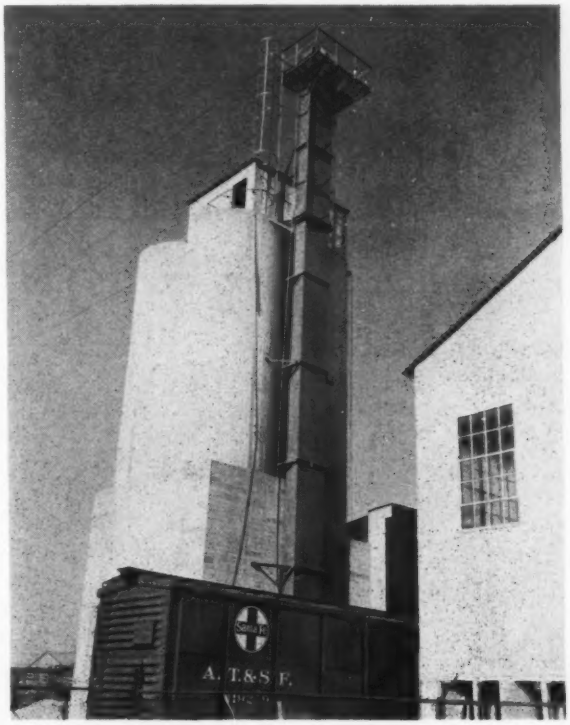
All slopes of bin bottoms, chutes, and hopper sides and bottoms have been made considerably steeper than usually recommended for the materials that flow through or over them by gravity. As an additional safety factor, compressed air outlets at fifty pounds pressure are inserted in the bins and chutes at all vulnerable points. All machinery was made easily accessible for greasing and oiling, and all moving parts were fitted to be greased by a pressure grease gun system. The conveying machinery is enclosed and practically dust proof.

Considerable thought was given to the selection of the power units. Each machine in the entire plant is individually motorized with carefully selected units to suit the individual requirements of the machine.

Induction motors were used for general purposes. Where integrally geared motors and slow speed were required, self-contained units with a high power factor and high efficiency at slow speeds were employed. For adjustable speed drive, integrally geared, a unit similar to that just mentioned was used except arranged for adjustable speed. At positions of high power consumption synchronous motors were used, as this type has a high power factor and considerable saving in current cost results.

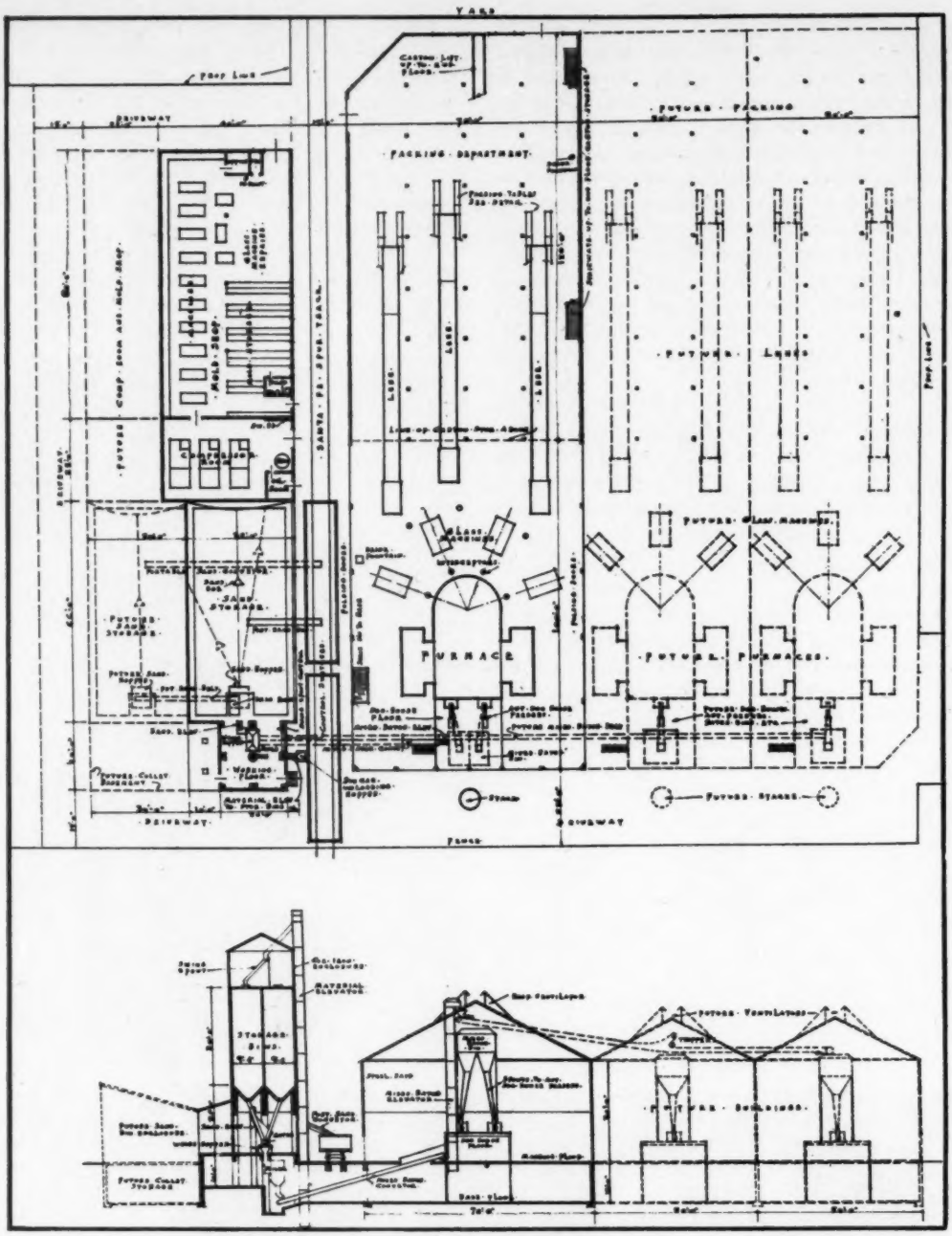
Belts were used in place of chains on all elevators, not only because gritty, abrasive materials used in glass manufacture quickly wear out chains, but also because belts are quieter.

The machinery units of the batch plant are switched with electrical interlocks so that one unit can not be started or stopped without previously starting the connecting unit. This is a necessary precaution as it is very



Raw materials are stored in upright storage bins, resembling silos, from which they are withdrawn by gravity.

Electric lift trucks are used extensively throughout the plant and greatly facilitate the handling of materials and finished stock economically.



This present layout of the plant shows provisions made for future expansion.

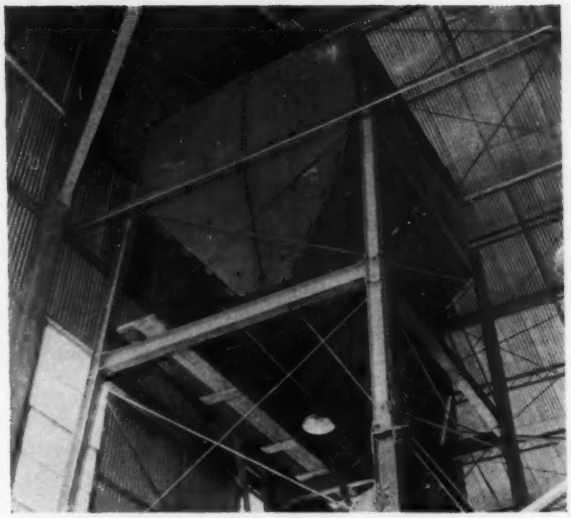
easy without such an inter-lock to choke up and damage a unit by discharging into it before it has been started.

Elevators are provided with electric safety brakes and all moving parts are well protected with safety guards. All chutes are double gated so that the chute can be removed without emptying the bins. Air, water, and drainage outlets were provided at convenient points so that mixer hoppers, etc., can be thoroughly drained and cleaned before a change from colored to flint glass is made.

The same batch plant is made to handle one, two, or three tanks from the same central point. Although the present plant has but one tank, it can be expanded to an ultimate three tank capacity without interrupting production and at comparatively small expense for batch handling equipment. In fact, the expansion possibilities of a plant laid out in this manner are almost unlimited.

In designing the packing department, the same care was taken to eliminate labor waste as had been used in the batch plant. It also was borne in mind that labor convenience in this portion of the building was very conducive, not only to labor saving, but also to a careful and uninterrupted sorting of the ware to be packed.

Knocked-down cartons are unloaded from the manufacturers' trucks onto a carton conveyor. By it they are transported to the second floor of the packing, or lehr



The finished batch storage hopper high above the furnace. Another instance of saving by the use of gravity.

building, where the stitching machine is located. The operator places the cartons, as she stitches them, on a table where the carton divisions are installed and the complete carton is slid to any of the six holes in the table, each leading to a separate chute. Each side of each lehr is served by a separate chute, permitting the cartons to slide easily onto the roller packing tables. There is a packing table for each side of each lehr.

Packing tables hold from eight to twenty cartons, according to the size of the carton being used. The packing portion of the table is hinged so that when wooden crates are being packed they may be tilted at any convenient angle. When packed, the table can be returned to the horizontal and the crate shoved forward with a minimum of effort to make place for the next empty. At the side of each table in an almost vertical position is another set of rollers and guides made to hold off ware trays.

This arrangement, with a roller table convenient for handling both packed and off ware, and an individual, automatic supply of cartons to each packer, allows the packer to spend his entire time in sorting and packing, without moving from one spot.

The packing tables also allow for quite an accumulation of packed and off ware. Electric mules are used to transport the packed ware from the tables to the warehouse and from the warehouse to the freight cars or trucks.

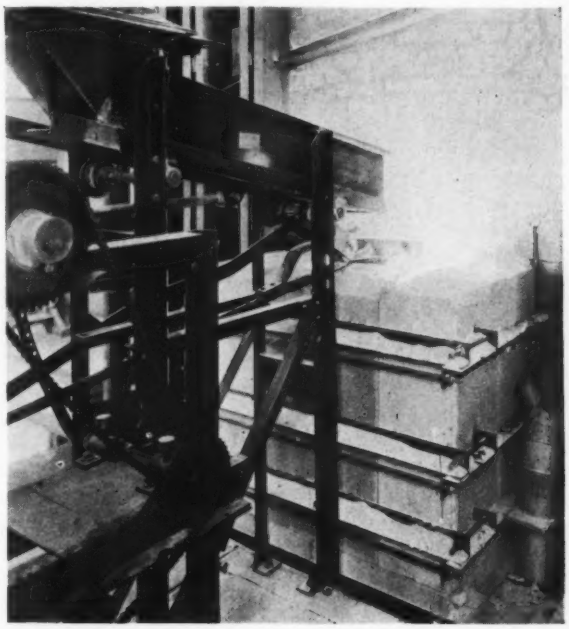
All of the other equipment, the tank, feeders, mould machines, lehrs, compressors, etc., are the most modern the market offers. The mould shop is lighted by north light and the equipment is individually motorized. There is a basement under the tank and mould machines for the storage of cullet that comes directly from the interceptors and for the off ware from the mould machines. Three blowers, using a total of 140 horsepower, furnish wind for tank, forming machine, and operator cooling. A very workmanlike pipe system designed to give ample pipe sizes and runs of gas, water, compressed air and wind to all required points is so placed that alterations easily can be made as differences in ware require.

Fifty air-changes an hour in the furnace building are obtained by ventilation on natural gravity principles. The cooling water from the compressors and the tank throat is cooled in towers, and then pumped back through the systems.

There are ample conveniences for the employees, such as wash and locker rooms, drinking fountains, etc.

The cost of crushing the cullet and the handling of the batch materials from the cars into the tank of the new Glass Containers' plant, including labor, supervision, insurance, electrical current, and upkeep and depreciation of machinery, is less than forty cents per ton of glass poured.

It is estimated that the difference in cost of batch handling between the discarded and new plants will pay for the new batch plant and carton handling equipment in a year's time, or it will pay a conservative 16 per cent on the entire investment, paying for the entire new portion of the plant in approximately 7½ years, and at the same time pay 7 per cent on the unreturned portion of the investment. This does not take into account the



The batch is pushed into the furnace by a "mechanical hoe," copied after the age-old hoe. Its use permits a perfectly mixed batch to flow in a steady stream at each dog house.

greatly increased production and the better quality of ware due to uninterrupted mechanical handling which makes possible slow, continuous, constant, and un-demixed batch feeding to the furnace by the automatic dog house feeders.

These savings, based on a one tank, four machine plant, would be greatly increased as the plant is expanded to a two, three, or four tank factory, as most of the cost of the batch plant is necessarily in the first unit. A further saving can also be made by using the tank man as a batch man. The automatic feeders eliminate all manual labor on his part and the batch for a 50 ton pour can be mixed by him in less than four hours of his eight hour shift, leaving him at least half of his time to watch the fires.

TARIFF LOWERED ON PLATE GLASS AND GLASS SAND

Import duties on plate glass were reduced one-third and on glass sand one-half, under the terms of a trade treaty signed on February 27 between the United States and Belgium. American glass manufacturers are very seriously concerned over the situation. Belgium is the largest exporter of plate glass to this country; but it is not Belgian competition that is causing the greatest alarm as the fact that the treaty with Belgium more or less automatically lowers tariff duties to every other nation.

The national policy, as defined by Act of Congress, requires that when a tariff concession is granted to one nation, the same concessions would automatically be extended to all other favored nations. The Act leaves it optional with the Administration whether to extend such concessions to non-favored countries. In so far as the Belgian treaty is concerned, it has been announced that the latter policy would be pursued with all the powers except Russia. Applied to glass, this means that Japan, Czeckoslovakia, Germany, or any other country can ship plate glass at these lowered duties.

The new tariff becomes effective thirty days from the date of its proclamation. As a definite test of the Administration's policy, it is a foregone conclusion that Japan will send a shipment of plate glass to this country the end of March, and, if entry at the lower rate is denied, that a protest will be made to the State Department. The latter either will have to make good its promises or become embroiled in international com plications. Japan, incidentally, placed an order for plate glass machinery with an American manufacturer this winter that ran into several hundreds of thousands of dollars.

The one saving grace in the situation, if it may b called such, is the provision in the Belgian pact that if, as a result of any change in duty, third countrie should obtain the major benefit; or if an increase in imports from such other countries should become unduly burdensome, the duty may be withdrawn after consultation between the two governments. However, those who have had experience in attempting to secure tariff changes after they have once been established believe that this safeguard is not a particularly strong hope to rely upon.

M. I. T. OFFERS ADVANCED DEGREES IN CERAMICS

The Massachusetts Institute of Technology has just announced the establishment of advanced degrees in ceramics. The Institute's course in ceramics will hereafter offer advanced work leading to the degrees of Master and Doctor of Science.

Candidates for the new doctorate, in addition to strictly ceramic subjects, must have a thorough knowledge of physics, chemistry, physical chemistry, combustion, furnace design, x-ray and crystal structure, drying, heat measurements and colloids. The degree of master of science will be awarded to students who pass with high standing a required number of advanced subjects. In awarding either degree, major emphasis will be placed on an original and convincing thesis.

Among the advanced special studies offered are optical ceramics, the investigation of products and materials with the petrographic microscope; fundamental ceramic processes, a detailed study of physical and chemical mechanism; the physical properties of ceramic products, dealing with properties of finished ware, methods of testing, and control of quality; and special problems, in which the student may choose his own topic of research.

FIRST EUROPEAN EXHIBIT OF AMERICAN HANDBLOWN GLASS

Proof that Europe is beginning to recognize the excellence of American handblown glass and of American craftsmanship is offered in the forthcoming exhibit by Steuben in London, March 20, at the Society of Fine Arts. This is the first time American handblown glass has ever been sponsored by a foreign group. There are twenty-one pieces, all of them designed by Sidney Waugh, Prix de Rome winner in sculpture in 1929, and executed by craftsmen of Steuben Glass, the art division of Corning Glass Works. Among the twenty-one are a bowl engraved with the twelve signs of the zodiac, which has been acquired by the Victoria and Albert Museum in London; the Apollo vase, the Adam and Eve vase, the Ganymede vase, the Trident punch bowl, the Venus vase, the Gazelle bowl, the Pegasus vase, the Andromache vase and the Unicorn vase. The exhibition will last until April 10, after which date Steuben glass will be sold by the firm of Edward Thower & Co., Ltd.

American connoisseurs were favored with a two day preview of seventeen of the pieces at the Knoedler Galleries, New York, on February 27, following which the collection was taken to London on the S. S. Majestic by Arthur A. Houghton, Jr., president of Steuben Glass.

The Hercules Bowl (left) and the Zodiac Bowl (right). The latter has been acquired by the Victoria and Albert Museum.

DEFECTS PRODUCED BY STONES IN GLASS*

By HERBERT INSLEY

Prefatory Abstract. It is pointed out that "stones" in glass give rise to other defects besides the unsightliness which usually causes the rejection of the ware containing the stones. The thermal expansions of the crystals commonly found in stones and of glass are compared. The need for qualitative correlations of the type of stone with the amount of breakage caused by the stone, and with the presence or absence of associated cords and lumps, is indicated.

CRYSTALLINE solids occurring in glass are known by the glass maker as "stones", regardless of their source. The unsightliness of the stones themselves is probably the primary reason for rejection of the ware containing them, but the presence of stones results also in other defects. In at least one damage suit an attempt was made by the plaintiff to show that breakage of a bottle was due to a stone. Even though actual breakage does not occur, the presence of stones often gives rise to such secondary defects as cords and lumps. Indeed, these evidences of stones may persist after the stones themselves are completely dissolved. Differences in the rate of contraction during cooling between glass and included crystalline material cause stresses in the glass, the nature of which may affect the tendency to breakage.

A rough correlation of breakage occurring in stony ware with the nature of the crystalline material in the stone indicates that some types of stones increase the likelihood of breakage while other types actually decrease that likelihood. There are practically no data as to the relation of breakage to the type of stone, and this paper is primarily an appeal to glass technologists to take note of the amount of breakage in stony ware as compared with clear ware and if possible to correlate these observations with the type of stone occurring in the ware.

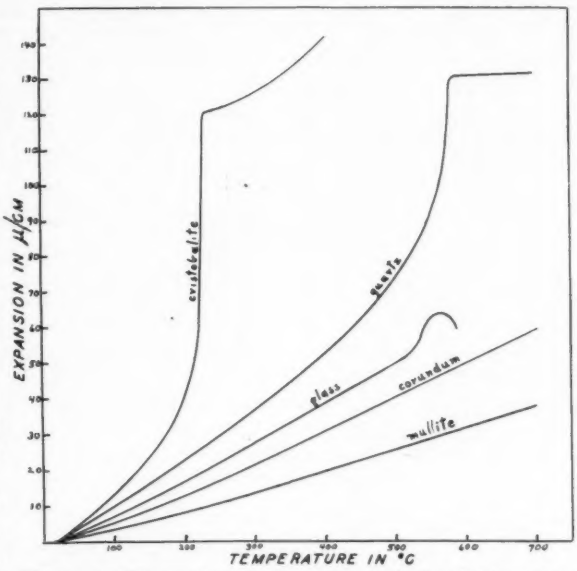


Figure 1. Thermal expansions of a typical soda-lime glass and some of the principal crystalline constituents of stones. Quartz and cristobalite curves plotted from data by Paul Braesco, Annal. physiq. 14, 5-75 (1920). Curve of glass from C. G. Peters and C. H. Cragoe, Jour. Opt. Soc. Amer. 4, 105-144 (1920). Mullite and corundum curves plotted from data by R. A. Heindl, Bureau of Standards Journal of Research 10, 715-735 (1933).

Comparison of Physical Properties of Stones and Glass

In the absence of statistical information on the relation of type of stone to breakage, strain, etc., it may be of value to compare some of the physical properties of crystalline materials commonly occurring in stones with those of the glass in which they are inclosed. Stones may conveniently be divided into three types according to their source: (a) Crystallization of the glass itself (devitrification stones). (b) Incomplete melting of some batch constituents (batch stones). (c) Particles of the tank lining (refractory stones).

Devitrification Stones

We may eliminate devitrification stones from consideration at once since they commonly occur as minute skeleton crystals, as thin fibers radiating from a nucleus, or as slender prismatic crystals along a cord in the glass. These crystals are interspersed with relatively large amounts of glass and their effectiveness in producing rupture or even notable stress in the glass is negligible. The cords oftentimes associated with devitrification crystals are not the result of the crystallization but rather the cause of it. The origin of the cords must be looked for in an inhomogeneity which was produced before crystallization took place, whether by batch segregation, convection currents or some like cause.

Batch Stones

Batch stones are the result of incomplete melting of one of the batch constituents and since sand is the most refractory constituent in the usual commercial glass, it is the partly dissolved quartz grains which are commonly the crystalline material in batch stones. Quartz has an extremely high thermal expansivity (fig. 1) in the temperature range of the alpha-beta inversion, but fortunately in this range (near 573°C) the glass is relatively soft and may readily adapt itself to the sudden contraction of the inclosed quartz grains during cooling.

A type of stone which is a combination of devitrification and batch stone is that caused by entrainment in the glass itself of the siliceous scum often formed on the melting surface of the glass. This scum is probably formed by the rise of partially melted quartz grains through the heavier glass and their accumulation behind the bridge wall. This highly siliceous surface layer is added to by drops from the silica brick crown. During exposure to high temperatures the quartz is converted to a mixture of cristobalite and tridymite. Through enlargement of the bridge throat or partial failure of the bridge wall, portions of this scum may be drawn through the refining end of the tank and eventually appear in the glass forming the finished ware.

*Publication approved by the Director of the National Bureau of Standards of the U. S. Department of Commerce.

Figure 1 shows the linear thermal expansion of cristobalite as compared to that of typical commercial soda-lime glass. During cooling a sudden and very great contraction is suffered at the temperature where the inversion from high temperature to low temperature (beta to alpha) cristobalite takes place. Unfortunately, the glass is rigid at this temperature and if the cristobalite stones are large, they may break away from the inclosing glass or rupture it. Flakes of entrained scum composed largely of cristobalite have been observed which shattered the immediately surrounding glass to a fine powder even after the glass had cooled to room temperature. Fine-grained cristobalite particles scattered through the glass do not cause shattering of the glass as does a relatively large concentration of cristobalite. Indeed, Grieg[1] has noted that in many cases where minute cristobalite particles are enclosed in glass the surrounding glass has actually prevented the inversion from the high to the low temperature form. Hollows have frequently been observed in the surface of the ware immediately over stones composed largely of silica, the cause of which is unknown. They may be the result of the very rapid contraction of the crystalline silica during cooling through the lower temperature range or are possibly due to a lowering of the viscosity by partial solution of the stones although the direction of such a viscosity change is contrary to what would be expected from extrapolation of known viscosity data. Partial solution of the stones also is responsible for the cords which are almost invariably associated with them. These cords provide an additional method for identifying the stones since the glass in cords associated with silica stones has a lower index of refraction than the usual commercial soda-lime glass in which they may be inclosed, while cords associated with all other types of stones have a higher index of refraction. Strained areas in the glass immediately surrounding silica stones should give optical evidence of tensile radial stresses because cristobalite, tridymite and quartz have higher rates of contraction than does the surrounding glass.

Refractory Stones

Refractories for glass melting are almost solely of two types: (1) silica refractories commonly used only in the crowns and upper side walls of tanks, and (2) aluminum silicate refractories used in the parts of the tank in contact with the molten glass as well as in certain locations above the flux line. The stones from silica refractories do not differ essentially from the silica stones already discussed. Aluminum silicate refractories, whether they are made of kiln-treated clay or of electrically fused material, contain a large percentage of mullite. During reaction with the molten glass or with the alkaline dusts in the tank atmosphere the mullite is converted to corundum and liquid, and these in turn may further react with the molten tank glass to form nephelite. Nothing is known of the thermal expansion of nephelite, but the thermal expansions of corundum and mullite have been determined and typical curves for these two compounds are given in Figure 1. While the expansivity of corundum is almost twice that of mullite, they are both somewhat less than that of soda-lime glass. During cooling, therefore, the contraction of the glass is slightly greater than that of the inclosed refractory stone and the glass immediately surrounding the stone should give optical evidence of compressive radial stresses. Moreover, the difference between the expansivity of corundum and mullite and of glass is much less than the difference between that of the silica minerals and glass.

There is almost invariably a lump in the surface of drawn sheet or hollow blown ware overlying the clay refractory stone which is apparently due to a relatively higher viscosity of the glass containing some of the alumina and silica dissolved from the stone than that of the glass of normal composition, since the lump is much larger than can be accounted for simply by the presence of the solid crystalline stone. It has also been observed in breaking clay refractory stones out of glass that the fracture frequently takes a course around the stone and not through it. Whether this is due to increased strength of the immediately adjacent glass by solution of some of the aluminum silicate or whether it is related to the stresses developed has not been determined.

To summarize, qualitative observations as to the ease of breakage of the stony glass and the character of the lumps and chords associated with the stones are advocated. Where petrographic determination of the type of stone can be made, such observations should not require an excessive amount of time and may lead to valuable generalizations as to the relative harmfulness of different types of stones.

WILL LECTURE ON GLASS

Dr. Alexander Silverman, Head of the Department of Chemistry, University of Pittsburgh, will make a tour of the southern Sections of the American Chemical Society, lecturing on "Glass: An Indispensable Factor in Modern Civilization." The schedule follows:

March 19—Lexington Section at Lexington, Kentucky.
March 20—East Tennessee Section at Knoxville.
March 22—Georgia Section in Atlanta (This will be a joint meeting with the Georgia Academy of Sciences.)
March 23—Alabama Section at Birmingham.
March 25—Louisiana Section at New Orleans.
March 27—Florida Section at De Land.
March 30—Virginia Section, with Hampton Roads Chemists Club at the College of William and Mary at Williamsburg.

The Society of Glass Technology, London, will hold its annual meeting on April 10, at which time officers for the ensuing year will be elected. B. P. Dudding has been nominated for president. Francis C. Flint, Hazel-Atlas Glass Company, is nominated to succeed himself as American Treasurer.

TO STUDY ORIGIN OF CLAYS

The Geological Society of America has presented the Massachusetts Institute of Technology with a grant from the Penrose Fund for a study of the origin of clays. The investigation will be carried out under the direction of Professor Frederick H. Norton, who is in charge of instruction and research in ceramics in the department of mining and metallurgy. Dr. Norton was the author of a paper "Color Formation in Glasses and Glazes" appearing in the February issue of The Glass Industry.

INDEX OF REFRACTION, DENSITY AND THERMAL EXPANSION OF SOME SODA-ALUMINA-SILICA GLASSES AS FUNCTIONS OF THE COMPOSITION*

By C. A. FAICK, J. C. YOUNG, D. HUBBARD AND A. N. FINN

Abstract. The index of refraction and density of 44 soda-alumina-silica glasses and the thermal expansion of 29 of the glasses were determined. The composition of the glasses, which varied from one to ten per cent alumina, 19 to 45 per cent soda and 50 to 78 per cent silica, was determined by chemical analyses. The data are given in tabular form and graphs are presented from which the index of refraction, density, critical and softening temperatures, and the linear thermal expansion from room temperature to these temperatures can be predicted with reasonable accuracy for any glass in the series studied. The substitution of alumina for soda and silica in the proper ratios will give glasses having the same refractivity, density and expansion as the original soda-silica glass; these ratios are approximately 1:1.8, 1:1 and 1:1.5, respectively. On the expansivity for a given temperature range the effect is about the same as that of silica.

Introduction. Certain relations between chemical composition of some soda-lime-silica glasses and their index of refraction, density and thermal expansion were presented in three previous reports.[1] This report is the result of a study of similar relations for a series of soda-alumina-silica glasses.

In the first report the purpose of the general study was given, the method of making glasses was described, essential parts of the methods of chemical analysis and the condition of annealing were outlined, and the method of measuring index of refraction was detailed. Density determinations were discussed in the second report and the third report contained the necessary details for measuring thermal expansions.

Since the soda-alumina-silica glasses were made and handled in the same way as the soda-lime-silica glasses, descriptions of the methods involved will not be repeated in this report.

Scope. Forty-four glasses, containing approximately from one to ten per cent alumina, 50 to 78 per cent silica and 19 to 45 per cent soda, were made and tested. The index of refraction for sodium light, and the density at approximately 20°C were determined for all the glasses; the thermal expansion and the critical and softening temperatures were determined for only 29 of them. All the data obtained, including chemical composition, are given in Table I.

Changes in the Observed Properties of the Glasses with Changes in Composition. Correlation of the measured properties and composition of the glasses, as shown in figures one to four, was based on the procedure used for density-composition relations described in the following paragraph.[2]

The data were first plotted on a triordinate diagram according to their compositions. Then lines of constant density were obtained by first interpolating graphically between several pairs of neighboring points so chosen as to be near to a trial constant density value, and then sketching the lines through the interpolated points. The intersections of these lines with the silica-soda base line were established from the published data for that series of glasses.

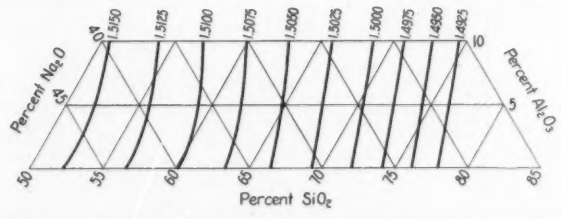


Fig. 1. Diagram showing relation between composition and index of refraction of some soda-silica-alumina glasses.

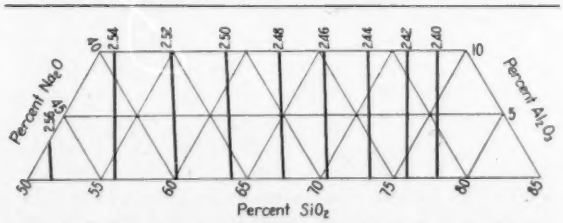


Fig. 2. Diagram showing relation between composition and density of some soda-silica-alumina glasses.

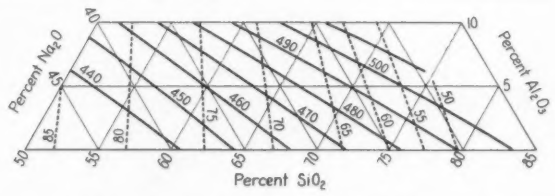


Fig. 3. Diagram showing relation between composition of some soda-silica-alumina glasses and critical temperatures (solid lines) and also linear expansions (broken lines) from 25°C to those temperatures. Temperatures are given in degrees C and expansions in microns per cm.

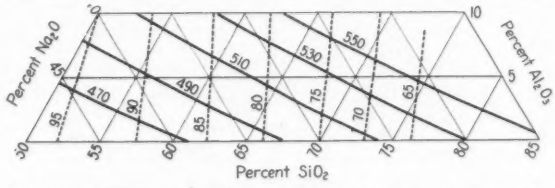


Fig. 4. Diagram showing the relation between composition of some soda-silica-alumina glasses and softening temperatures (solid lines) and also linear expansions (broken lines) from 25°C to those temperatures. Temperatures are given in degree C and expansions in microns per cm.

The effects of changes in composition on index of refraction, on density, on critical temperature and total expansion from room temperature to the critical temperature, and on softening temperature and the total expansion from room temperature to the softening temperature are indicated in figures 1, 2, 3 and 4, respectively. The difference between the observed value of any of the properties of the alumina glasses and the value

*Publication Approved by the Director of the National Bureau of Standards of the U. S. Department of Commerce.

[1] C. A. Faick and A. N. Finn, The index of refraction of some soda-lime-silica glasses as a function of the composition. J. Am. Ceram. Soc. 14, 518 (1931). F. W. Glaze, J. C. Young and A. N. Finn, The density of some soda-lime-silica glasses as a function of the composition. BS J. Research 9, 779 (1932); RP 507. B. C. Schmid, A. N. Finn and J. C. Young, Thermal expansions of some soda-lime-silica glasses as functions of the composition. BS J. Research 12, 421 (1934); RP 667.

Table 1. Compositions, observed indices of refraction, densities, critical and softening temperatures, and linear thermal expansions between the indicated temperatures.[1]

No. Glass	Composition SiO_2	Composition Na_2O	Composition Al_2O	Index of Refraction[2] n_D observed	Density[2] Observed at 29°C	Critical temperature	Linear expansion 25°C to critical temperature	Softening temperature	Linear expansion 25°C to softening temperature
	Percent	Percent	Percent			°C	μ/cm	°C	μ/cm
101	50.32	46.82	2.86	1.5162(—1)	2.5605(+15)				
102	50.57	42.43	7.00	1.5154(—2)	2.5495(+10)	447(+2)	82.0(—1)	489(+2)	94.5(0)
103	50.86	42.43	6.71	1.5155(+3)	2.5485(+5)	447(+3)	83.7(0)	492(+7)	98.5(+4)
104	50.89	39.54	9.57	1.5150(+2)	2.5410(—3)	455(0)	82.0(0)	501(0)	99.0(+6)
105	50.95	44.17	4.88	1.5157(0)	2.5533(+13)	435(—1)	84.2(0)	472(0)	94.8(0)
106	55.25	34.92	9.83	1.5116(+2)	2.5182(—5)	477(+4)	76.0(—1)	517(0)	86.2(—2)
107	55.56	37.50	6.94	1.5120(—1)	2.5259(+11)	457(0)	77.2(0)	501(+1)	90.5(+2)
108	55.66	34.66	9.68	1.5110(—2)	2.5163(—7)				
109	55.80	41.32	2.88	1.5130(+2)	2.5364(+22)	440(+2)	79.0(0)	484(+9)	91.5(0)
110	55.86	39.23	4.83	1.5124(0)	2.5304(+16)	445(—2)	78.9(+1)	492(+3)	93.0(+4)
111	60.45	29.71	9.84	1.5072(+1)	2.4897(—12)				
112	60.68	34.46	4.86	1.5088(+2)	2.5032(—8)	465(+3)	74.0(0)	504(0)	86.2(+2)
113	60.76	36.42	2.82	1.5092(+1)	2.5111(+19)	455(+2)	75.4(—1)	491(+1)	86.0(0)
114	60.78	38.13	1.09	1.5094(0)	2.5168(+30)				
115	60.88	29.53	9.59	1.5070(+2)	2.4891(—4)	495(+2)	68.8(—1)	530(—7)	79.4(—2)
116	60.97	32.46	6.57	1.5073(—5)	2.4977(+3)				
117	64.78	34.20	1.02	1.5059(—2)	2.4916(—13)	458(+1)	72.2(0)	500(+10)	84.5(+3)
118	65.10	24.94	9.96	1.5032(+1)	2.4615(—5)	510(+2)	65.2(+1)	561(0)	76.8(0)
119	65.70	29.55	4.75	1.5049(+7)	2.4749(—6)	475(—3)	70.4(+2)	530(+12)	84.6(+8)
120	65.88	24.69	9.43	1.5025(—1)	2.4580(+1)	505(—3)	62.0(—1)	550(—10)	72.0(—3)
121	65.90	31.23	2.87	1.5052(+6)	2.4830(+25)	470(+3)	72.0(+3)	500(—5)	85.2(+7)
122	65.92	31.67	2.41	1.5047(0)	2.4814(—3)				
123	66.36	31.61	2.03	1.5050(+5)	2.4805(+3)	470(+6)	67.2(—2)	517(+14)	83.0(+5)
124	67.21	28.34	4.45	1.5026(—4)	2.4653(—13)				
125	67.75	29.30	2.95	1.5030(—3)	2.4683(+1)				
126	68.10	25.15	6.75	1.5018(+3)	2.4539(+11)	493(—3)	63.0(0)	540(—3)	74.2(0)
127	68.78	25.45	5.77	1.5006(—1)	2.4534(+18)				
128	69.99	29.04	0.97	1.5020(+4)	2.4612(+10)	470(0)	69.6(+4)	515(+10)	81.5(+7)
129	70.11	27.86	2.03	1.5015(—1)	2.4572(+17)	476(+2)	65.1(0)	520(+8)	76.5(+4)
130	70.30	24.84	4.86	1.5003(+3)	2.4445(—1)	490(0)	60.3(—1)	535(—2)	70.4(—1)
131	70.63	24.45	4.92	1.5000(+4)	2.4428(+7)	490(—2)	61.0(0)	541(+3)	76.9(+6)
132	70.84	26.31	2.85	1.5007(+6)	2.4509(+34)				
133	70.88	22.63	6.49	1.4988(+1)	2.4343(—11)	500(—1)	57.7(0)	553(0)	69.5(0)
134	71.08	19.60	9.32	1.4970(—2)	2.4214(—10)	522(0)	54.0(+1)	570(—5)	67.5(0)
135	73.15	25.87	0.98	1.4984(+2)	2.4396(+11)				
136	73.81	21.50	4.69	1.4957(—2)	2.4181(—5)	502(+2)	53.0(—2)	552(+4)	64.0(—2)
137	74.75	24.27	0.98	1.4970(+3)	2.4277(+7)				
138	74.88	22.12	3.00	1.4955(—2)	2.4162(—1)				
139	74.95	23.98	1.07	1.4960(+1)	2.4234(—13)	481(—4)	60.2(+2)	531(+9)	74.8(+8)
140	74.98	23.02	2.00	1.4952(—3)	2.4186(—16)	490(+2)	57.7(+1)	539(+9)	66.0(0)
141	75.21	19.67	5.12	1.4934(—5)	2.4025(—1)	502(—2)	48.2(—2)	550(—5)	54.8(—9)
142	75.48	19.70	4.82	1.4935(0)	2.4022(+7)				
143	75.61	21.54	2.85	1.4949(+4)	2.4117(+20)	495(0)	54.5(+1)	539(0)	66.0(+2)
144	77.71	21.36	0.93	1.4926(—2)	2.4013(+31)				

[1]The figures in parentheses, when subtracted from the observed values, give computed values, or those obtained from figures 1, 2, 3 and 4.
[2]The parenthetical figures in these two columns have been multiplied by 10^4.

read from the appropriate figure is given parenthetically in table 1. Similar differences for the alumina-free glasses were presented in the reports previously cited.

It can be shown from a study of the graphs that additions of alumina to the soda-silica glasses should not significantly change the refractivity, density or expansion to the softening point if, for the amount of alumina added, the silica and soda are reduced in the ratio 1:1.8, 1:1 or 1:15, respectively; the expansion to the critical temperatures changes, however, the ratio of substitution in the high silica region being about 1:0.22 and in the low silica region about 1:1.

In the report on expansion of the soda-lime-silica glasses, equations were given for computing the expansions of these glasses in any range between 25° and 450° C. Following the procedure used for evaluating the constants in those equations, constants were computed from the data on the soda-alumina-silica glasses, as follows:

$$E = aA + bB + dD$$
$$a = 0.00043t - 0.0000003t^2$$
$$b = 0.00274t + 0.0000035t^2$$
$$d = 0.00001t - 0.0000003t^2$$

in which E is the linear thermal expansion in microns per centimeter, between 25°C and any temperature T less than 400°C, t = T—25, A, B and D are the percentages of silica, soda, and alumina, respectively, and a, b and d are the indicated functions of temperatures. Although these constants were computed without respect to those previously reported,[3] it is noteworthy that the expansions for the soda-silica glasses computed from either set of constants for silica and soda are approximately the same. The average deviation (with approximately equal distribution between positive and negative values) of the calculated from the observed values of E at temperature intervals of 50° between 100° and 400°C, increased from 0.3 micron per centimeter at

[3]The following type of correlation was also worked out, but is not reported here. An algebraic solution, based on the previously reported factors for silica and soda, was used to determine factors for alumina, and from these factors constant density and refractivity lines were drawn on triordinate diagrams. This procedure necessarily yielded "break lines" (discussed in the report on density of the soda-lime glasses) running obliquely across the diagrams, thus dividing the field into four areas, corresponding to the number of silica-soda groups. Very little weight could be attached to the locations of these lines, however, owing partly to the limited amount of alumina present and partly to the fact that the total changes in the magnitude of the properties measured were relatively small.
[4]The previously reported values are:
$a = 0.00036t - 0.00000036t^2$
$b = 0.00245t + 0.0000046t^2$

100°C to 1.0 micron per centimeter at 400°C, the maximum individual deviation being 2.5 microns per cm.

Attention should be directed to the fact that the substitution of alumina for silica produces a very slight reduction in expansion to 400°C. This agrees with the conclusion reached by Turner and his coworkers[4] that the effect of alumina on expansion may be about the same as that of silica.

It may also be stated that, where comparisons can be made, the refractivity and density of the alumina glasses reported by us agree reasonably well with the results reported by Turner and his coworkers[5] if the small amounts of impurities in their glasses are taken into consideration.

[4]S. English and W. E. S. Turner, The thermal expansions of glasses containing aluminium, J. Soc. Glass Techn, 5, 183 (1921); and Violet Dimbleby, S. English, F. W. Hodkin and W. E. S. Turner, Further investigations of the influence of alumina on the properties of glass. J. Soc. Glass Techn. 8, 173 (1924).

[5]J. R. Clarke and W. E. S. Turner, Note on some optical properties of the sodium-aluminium trisilicate glasses, J. Soc. Glass Tech. 5, 119 (1921); and S. English and W. E. S. Turner, The density of glasses containing aluminium, J. Soc. Glass Techn. 5, 277 (1921).

NEW ORLEANS EXHIBITS RARE GLASSES

Representative specimens of the products made by the Wistars, Baron Stiegel, Sandwich and other early American glass factories are included in the interesting glassware collection on exhibit in the Louisiana State Museum in New Orleans.

Among the type specimens are window glass, bottles and flasks, salt cellars, cup plates, goblets, drug and medicine bottles, demijohns, cupping glasses, lamps and lamp chimneys.

Noteworthy is the miniature liquor set of 12 crystal glasses and three decanters on a tortoise shell and ivory stand; a Venetian glass chandelier of the early 19th century; and a large collection of two, three, and four-mold flint and opaque glass of the middle 19th century.

The State Museum is located in the Cabildo which was erected in 1795 and which was the scene of the transfer of Louisiana from Spain to France and from France to the United States.

FIRST BIG U. S. TELESCOPE MIRROR

X marks the spot. Here, in the spring of 1895, nearly 40 years ago, the first great telescope disc of American make was cast. It was 62″ in diameter and 7″ thick, and weighed a little less than a ton. It was ground, polished and "figured" by the Rev. Peate (retired) of Greenville, Pa., and is now in Washington, D. C.

The plant is the "Old" Standard Plate, of Butler, Pa., and the circle is on the casting hall directly over the spot where the big lens was cast. The plant has since been bought by foreign interests, who operate it under a new name.

The disc, at the time of its casting, was the largest in the world, and remained the only large American lens until very recent times.

The white areas in the foreground and to the left represent about a million tons of comminuted sand, ground glass, and plaster of paris, the accumulated débris of 40 years' operation of the plant as a plate glass grinding establishment. It is about 90 per cent silica, and much of it passes a 300-mesh sieve. The débris of the mirror is not among it, as the grinding was done at Greenville.

Mr. Frank Preston has been asked by Dr. Hostetter to prepare a history of the big mirror, before the generation that made it shall have passed entirely away. The time is opportune, in view of the recent great developments at Corning of the trussed borosilicate mirrors and the popular interest excited by the 200″ mirror.

Photograph from the N. W. at 1000 ft. October 1, 1934. George McKee, pilot, F. W. Preston, photographer. Writer's plant in extreme lower left corner, partly cut off by margin of picture.

© 1935. Frank W. Preston

BLAST FURNACE SLAGS IN GLASS MAKING

IN THE search for glass batch materials that will give usuable glass at low cost, many investigators have given the use of blast furnace slags sericus consideration with the result that their possibilities and disadvantages are now fairly well understood. One of the earliest accounts of the use of blast furnace slag as a constituent of the glass batch is given by Biser in his book on glass manufacture[1]. This account so well analyzes the difficulties encountered by the present day investigations on the use of the blast furnace slags that it is quoted in full. "The idea of manufacturing glass from the waste cinder, or slag, of iron blast furnaces is by no means a new one. Iron slag contains many of the ingredients of common glass and it is possible that much of the early glass was metallurgical slag remelted. The sands prepared by pulverizing slag have been used for a long time in England and on the continent of Europe as a constituent of glass. A trace of sulphur is found associated with the lime in slag, but this readily passes away with heat. When the constituency of slag is once determined by analysis, and the proper proportion of additional materials have been determined, a very regular and uniform workable glass can be made, as actual experience has shown conclusively that the composition of slag is regular enough to warrant results sufficiently uniform for all practical purposes. Taking the above analysis as an example (see Slag D, Table I) it will be seen that the principal differences are in the silica, alkali and iron; but by combining 100 parts of slag, 10 parts of soda and 60 parts of sand, the constituents are altered to a compound of the precise nature required. The natural tint of the glass thus produced is greenish in color, but by "fining" and bleaching it can be made almost colorless. With some ores the slag contains silica enough, and with the addition of soda and arsenic becomes perfectly transparent. The constituents of slag are common to all green glass, and by dilution with purer materials, decolorizers, etc., slag glass can be brought up to almost any desired standard, consistent with its iron and other impurities. However, without attempting to predict the possibilities of its manufacture in the future, so far its use has been confined to the ordinary black, dark green and amber colored bottle glass."

Basore[2] in his investigations of the methods for the disposal of blast furnace slag, follows closely the above methods of slag glass production. Basore uses ordinary building sand and soda to reduce the lime content of the slag, and large amounts of arsenic to increase the transparency of the resulting glass.

In Europe, considerable work has been done on the use of slags in commercial glass production, Kitaigorodsky and Karev[3] state that the use of blast furnace slags made it easier to obtain a white glass than did the use of open hearth slags and that the batch containing the blast furnace slag required a much lower melting temperature. In their experiments, 30 parts of slag (composition given in Table I, slag No. A) was melted with 60 parts of sand and 10 parts of Na_2O, the latter being added as the carbonate in one case and as the sulphate in the other. When the carbonate was used the resulting glass was of a black to orange color; when the sulphate was the source of alkali, the resulting glass was of a good white color. The composition of the resulting glasses was approximately as follows SiO_2, 70%; Al_2O_3, 4%; CaO, 16%; Na_2O, 10%. It was also noted that when higher amounts of slag were used, considerable difficulty due to the separation of Wollastonite was experienced.

The high CaS content of blast furnace slag has lead Althof[4] to investigate its possibilities as a source of coloring material for amber glasses. Using a slag of the composition shown in Table I, Slag B, he finds that small additions of it to an ordinary batch gives glasses of pale amber colors. When the amount is increased to a maximum of 12.5 per cent of the batch a very desirable dark brown amber shade was obtained. In all cases the color is due to the sulphur content of the slag.

With the exception of the work of Basore[2], little other work on the use of blast furnace slags has been done in the United States. Its possibilities as shown by the work of the various investigations quoted above shows however that it has distinct possibilities, especially in cheap colored glasses, which should warrant further study of the subject.

TABLE I. ANALYSIS OF BLAST FURNACE SLAGS

Constituent	Percentage			
	A	B	C	D
SiO_2	32.26	32.20	33.12	40.00
Al_2O_3	11.99	10.55	15.30	16.00
Fe_2O_3	1.06	0.83	0.79	2.00
CaO	49.46	47.59	43.8	35.00
CaS	4.18	....	....	....
SO_2	0.23	....	....	....
MgO	....	7.25	2.06	6.0
MnO	....	0.19	3.0	....
S	....	2.11	2.21	....
P_2O_5	....	....	0.13	....

A—Russian Slag; B—German Slag; C—English Slag; D—Welsh Iron Slag.

[1]Bisor, B. J., "Elements of Glass and Glass Making", Glass and Pottery Publishing Co., 1899.
[2]Basore, C. A. "Transparent Alumina Glass from Blast Furnace Slag" Ala. Poly. Inst., Eng. Exp. Sta. Bul. 3, Vol. 26, No. 7, 1931.
[3]Kitaigorodsky and Karev, "The Use of Slags in Glass Manufacture", Trans. State Inst. Test Bldg. Mat. and Glass. U.S.S.R., No. 30, 1930.
[4]Althof, F. "The Use of Blast Furnace Slag in Glass Manufacture", Glashütte, 63, 604-606, 1933.

SOVIET ARTIFICIAL GLASS

The Soviet daily newspaper *"Sovkhosnaya Gazette"* (Sovkhoz Gazette) recently printed the following interesting information:

The Leningrad Institute of Plastics discovered after long experimentation, the method of production of colorless bakelite, artificial glass, called "Krystallite".

The method of preparation of glass from bakelite ore was known up to this time only in Germany and Japan, where it has been kept a secret.

"Krystallite" can be used successfully as a substitute for high grade and costly kinds of optical glass. Experiments showed that from practical standpoint, "krystallite" is better than the Japanese artificial glass, called "phenolite".

CORNING TO DEVELOP ARCHITECTURAL GLASS

ON FEBRUARY 27, the Corning Glass Works opened a showroom for architectural and illuminating glassware at 748 Fifth Avenue, New York City. This move marks not only an important forward step in extending the use of glass in building construction, but foreshadows the future importance of Corning as a contender in that field.

The new showrooms are believed to be the first of their kind in America. They not only will display and demonstrate Corning products already developed for this field, but will help "to make architects and others in the building profession acquainted with the Company's facilities for tackling glass problems, and also provide a convenient headquarters at which to discuss these ideas with glass men grounded in the technical aspects of these matters." For this latter purpose, the showrooms will include a laboratory, fully equipped for experimental work in the various phases of electrical lighting, as related to glass, where those interested in the most advanced aspects of illumination can even conduct their own experiments with glass forms.

Uses for glass which so far have been realized by comparatively few architects and engineers will be an integral part of the architectural and decorative treatment of the rooms.

Unusual ways of handling illuminating problems with beautiful effect will be demonstrated by such means as glass friezes and mouldings lighted from behind; and a stepped-forward ceiling in two steps, which are covered by glass mouldings and wired behind with four circuits of clear light and two circuits of colored lights. Each of these circuits will be regulated to illustrate the various effects obtainable. By this means, it will be shown a room is subject to a multitude of transformations by means of illumination.

Novel features of the exhibit will include numerous glass specimens developed for engineering and industrial uses which have lately been adapted to the architectural and decorative field. Among these will be glass cylinders such as are used for gasoline pumps; architects have found in them an answer to various lighting and heating fixture problems. Tubing created in the Corning laboratories has already made its appearance in the decorative field in the form of strikingly illuminated chandeliers and will be seen performing a practical and decorative use as a ventilating grill. Fluted glass tubing will prove its value as a concealed radiator grill, while airplane searchlight lenses used as chandeliers, and huge glass insulators developed for high-tension power lines, will suggest to the architect and artisan additional uses for glass forms confined until recently to very limited fields.

In the conference room of the exhibition premises, the decorative combination of glass and wood will be illustrated by wooden, swinging doors inset with octagonal

GLASS FINDS NEW ARCHITECTURAL USES

A modern fireplace. The hearth is of heat resistant pyrex as well as the firedogs and irons! The hearth mouldings are of silvered glass, with a huge block of glass (illuminated) inside the hearth serves as a remarkably effective decorative piece when the fire is not in use. The room is indirectly lighted through silvered glass vases set in each corner of the room, with the lamps concealed in the pillars. On the mantle are glass fish designed by Sidney Waugh.

Something strikingly new in a foyer set. The base is of frosted glass, in a geometric design almost modernistic in treatment yet sufficiently restrained to be wholly pleasing. The top is clear plate glass, with the flower vase and its base of cut crystal. The entire effect is enhanced by a mirrored wall placed behind the set, which catches the beam of white light from the ceiling above. Both pictures were taken at the new Corning showrooms in New York City.

Foyer of the Corning showrooms just opened at 748 Fifth Avenue, New York City. Illumination is effected by glass mouldings, a method that will find extensive application in private dwellings of the future.

panels of crystal glass, bearing floral and geometric designs, after the manner of treating bronze doors. A hearth of clear, heat-resisting glass tile, and furnished with a pair of andirons of the same material will prove that glass baking dishes, developed more than twenty years ago, were the actual forerunners of what is now considered something of an innovation.

The main showroom will present the complete line of Corning-Steuben architectural and decorative glass, and can be darkened by means of duraluminum window blinds so that the different kinds of lighting can be demonstrated under both daytime and nighttime conditions.

Although the Corning Glass Works actually has been making glass for structural and decorative purposes since 1928, its experiments date back many years earlier. However, in the light of future years, these researches may be regarded as a development of the present time. New structural glass materials are still being worked upon, concerning which the company is adopting its customary policy of reticence. These are expected to result in a decided increase in the use of glass in building.

METROPOLITAN MUSEUM ACQUIRES SWEDISH GLASSES

Recent accessions at the Metropolitan Museum of Art include two pieces of Orrefors glassware, the work of Viktor Lindstrand, who recently became associated with this establishment. The more unusual of the two is a rectangular vase of brownish purple glass, which deepens in color towards the base. A panther is represented on each of the four sides in a different pose. The other vase is of clear glass with fluent contours, the engraved ornament a kneeling girl with a child on her shoulders.

Another acquisition is a necklace by Lalique, consisting of crystal glass curiously fashioned in the form of lovebirds resting on tooth-like motives. The birds are arranged in confronted pairs on a silver chain. Other Lalique specimens are three finger rings of crystal glass with engraved floral designs. These are particularly unusual for the attractive coloring of the glass and the delicacy of the engraving.

LONDON SECTION VISITS GLASS WORKS

At the invitation of the Directors of Messrs. Lewis & Towers, Ltd., about 120 members of the London Section of the Society of Glass Technology recently visited the glass bottle works of this firm at Hartwell Street, Dalston Junction, London.

In welcoming the visitors, Mr. Frank Towers gave a brief history of the development of the firm which has been manufacturing bottles for about 50 years. Throughout the whole of this time the hand process had been employed, and only recently have machines been introduced for a small portion of the work. Mr. J. W. Ballans then read a paper entitled "Some Troubles in a Glass Factory", in which he described the difficulties which the firm had encountered and the manner in which they were overcome.

The members were then conducted by guides in small parties through the factory where they were given every opportunity for examining the furnaces and the machines and for seeing the manufacture of bottles of all sizes by both hand and machine processes. The department for the stoppering of the bottles was of particular interest.

PUBLICATIONS RECEIVED

Ultra Violet Transmission Changes in Glass as a Function of the Wave-Length of the Radiation Stimulus. By W. W. Coblentz and R. Stair, National Bureau of Standards. Proceedings of the National Academy of Sciences. Vol. 20, No. 12, pp. 630-635. December 1934.

An extension of the calculations of the data reported under the same title in Jr. of Res., Nat. Bur. Stds., 13, 773, Dec. 1934 (R.P. 744). This last named paper is in turn a continuation of research previously reported.

Young's Modulus of Elasticity at Several Temperatures for some Refractories of Varying Silica Content. By Raymond A. Heindl and William L. Pendergast, Jr. of Res., Nat. Bur. Stds., 13, 851, Dec. 1934 (R.P. 747).

Directory of the Refractories Institute. A complete, up-to-date directory of the membership. Members are listed alphabetically as well as geographically, with the products and brands that each company manufactures. A third section lists all brand names alphabetically and gives the names of their owners.

A READER WRITES

A. Mathieu, the director of Parra-Mantois & Co., Paris, takes exception to some of the statements of I. V. Grebenstchikov in his review of the achievements of the U. S. S. R. in the manufacture of optical glass which was published in the October issue of The GLASS INDUSTRY. His letter in part follows:

Mr. Grebenstchikov is poorly informed in writing that the optical glass industry is non-existent in France. The Etablissements Parra-Mantois were created in 1827 at Paris and up to the time of the founding of the Verreries Schott in Germany in 1884 were well-nigh exclusive suppliers of scientific glass the world over.

It would be hard to believe, in view of the long existence of the Etablissements Parra-Mantois, that they have become stagnant or have fallen into decay. On the contrary, they have been developed from year to year and their present organization has no reason to envy the younger foreign industries that manufacture optical glass.

Proof of this is existent in the fact that it exports more than 50 per cent of its production to all industrialized countries of the world and more particularly to Germany. Also, during the World War the firm of Parra-Mantois undertook to furnish the Allied Armies, including the Russian Army with practically the total of optical glass needed by them.

The majority of the observatories of the earth, including that of Pulkow in the U. S. S. R. are equipped with glass of Parra-Mantois. In addition, the most important astronomical objective at present in service at the Yerkes Observatory (U. S. A.), measuring 1mO2 came out of the crucibles of Parra-Mantois. If the Observatory of Pukow had addressed itself to Parra-Mantois, it would not have had to wait 10 years for the delivery of an objective of 1m25 opening, available in our storehouses.

Our catalog includes more than 200 types of glass and whatever is of interest to glass technology or glass engineering is actively studied by our laboratory staff.

Although we have not yet had an opportunity to appraise it, we do not desire to belittle the progress made in the U. S. S. R. in the manufacture of optical glass since the revolution, which has been greatly facilitated by the collaboration of German technicians by the closing of a Berlin plant some ten years ago. However, our numerous friends and faithful clientele would not understand it if we let it be said that our industry is in decadence and is leading a miserable existence.

EDWARD BAUSCH CELEBRATES 60 YEARS OF SERVICE

Edward Bausch, president of the Bausch & Lomb Optical Company, Rochester, N. Y., last month celebrated his sixtieth year of active participation in the affairs of his company. Bausch & Lomb is an organization of enthusiasts who are always too profoundly wrapped up in their work to find time to think of retiring. Edward Hilgenreiner, aged ninety-three, came to the company in 1874. William Bausch, with fifty-nine years of service, is still as active in research as when he began his experiments in optical glass 20 years ago. Seventeen men have been with the company at least 50 years, and 310 for 25 or more years.

OWENS-ILLINOIS EARNINGS UP

Net earnings of the Owens-Illinois Glass Co. and subsidiary companies for the year 1934 were $6,496,359 as compared with $6,032,311 for 1933. This is equivalent to $5.41 per share as compared with $4.86 the year previous. Included among new assets is a 100 per cent stock ownership of the Closure Service Corporation.

PLATE GLASS PRODUCTION JUMPS

The total production of polished plate glass by members of the Plate Glass Manufacturers Association for the month of January was 13,365,188 sq. ft., as compared to 8,389,957 sq. ft. produced by the same companies in the preceding month, and 7,607,195 sq. ft. produced in the corresponding month last year.

BOTTLE WOULDN'T BREAK—GOES TO JAIL

Because modern bottles are so well made, a citizen of Scranton, Pa., was sent to jail, according to the *Scrantonian*, the daily newspaper of that city. Recently, says the dispatch, Edward Sehn was driving along the highway when Constable James Berkebile ordered him to pull up. Sehn threw a bottle from his car on to the concrete pavement; but it failed to break and Sehn was committed to jail on charges of possessing and transporting liquor illegally.

A GLASS INDUSTRY investigator who looked into the matter was directed to the office of J. H. Weiss, of the United Feldspar Corporation. Mr. Weiss disclosed that there was nothing unusual in the failure of the bottle to break. "Obviously," said Mr. Weiss, "the manufacturer used feldspar in his batch."

LOWERING COSTS AND SPEEDING PRODUCTION IN THE GLASS INDUSTRY*

The glass industry is lowering costs and speeding up production by use of a more resistant material for the tanks in which glass is melted. The new material is an electric furnace product consisting of corundum and mullite bonded with a small percentage of glass. The molten alumina-silica mass is cast into moulds in such shapes as tank-blocks and after a few days' annealing in the product is ready for use.

When it first appeared a few years ago the electrocast block was seized upon by window-glass manufacturers and made practically standard construction because it greatly increased the percentage output of high-quality glass free from the striae caused by rapid solution of the ordinary tank-block. Now the manufacturers of bottles and other ware have convinced themselves that the electrocast product, in spite of higher first cost, lowers repair charges per ton of glass melted. Enough authentic history is at hand to show that on the average the electrocast block for 25% added cost of a tank repair will more than double tank life, which ordinarily ends in less than a year when the hot glass eats through the blocks. Repair costs per ton of product are reduced 35 to 50% or more, a substantial return on the excess investment.

Further advantages are gained through the greater refractoriness of the new block which adapts it to the higher tank operating temperatures toward which glass manufacturers are moving. Hotter tanks melt glass more rapidly and thus (1) speed up production, (2) increase productive capacity of a melting unit, and (3) again lower costs. Five years ago the bulk of the glass tonnage of bridgewall type of tanks was produced on an average of 12 square feet melting area per ton of glass per 24 hours and at temperatures of 1430°C (2600°F) or less. Production of 10 square feet to the ton was considered excellent. Today we find the industry in general and the progressive manufacturers in particular headed for the 6 square foot mark with operating temperatures of 1540° C (2800°F). Several manufacturers are already very near this mark.

Following its early adoption by window-glass manufacturers, largely for quality reasons, the electrocast block is now going out in volume into the broader glass industry as a decided factor in promoting efficiency. Sale of the block, begun in 1928, has developed steadily during the depression. The resulting opportunity to reduce cost of manufacture of the block itself has been reflected in prices substantially below those at first offered.

With regard to the possibility of improved efficiency in glass-making, the outstanding need at the moment is better tank design. Melting is a very large item in the cost of glass because present-day tanks actually use only a small percentage of the heat units in the fuel. Tank design will improve as refractories improve. Meantime, progress will no doubt be made by study and experiment with the materials now procurable.

*Article by E. C. Sullivan which appeared in Industrial & Engineering Chemistry, News Edition, September 10, 1934, Vol. 12, No. 17, Page 314.

The Jena Glass Works of Schott & Gen., Jena, is celebrating 50 years of service to science and industry in the manufacture of glass. It now manufactures 154 kinds of colorless optical glass and 58 colored filter glasses. In March a year ago it completed its twenty-five thousandth melt of optical glass. Fish-Schurman Corporation, New York, are agents for the Jena Works in the United States.

"FLAT GLASS"—A REVIEW

Flachglas. Being Vol. 8 of Das Glas in Einzeldarstellungen. (Akademische Verlagsgesellschaft m. b. H. Leipzig 1934).

This 170-page booklet is really three entirely separate pamphlets bound in one (paper) cover. The pages are numbered consecutively, but the figures accompanying the text are numbered anew in each section. Each section is by a different author, and the treatment is in quite different styles.

The first section, on drawn window glass, generally called sheet glass in this country, is by Dr. Konig, and extends over some 40 pages. It reviews separately, the history, present status, and operating experience, of the three modern methods of making sheet glass; viz, the Fourcault, Colburn, and Pittsburgh Plate processes. No time is wasted on the older methods, now largely extinct. The changes in glass composition that were needed, as the new methods came into use, are discussed, and some of the difficulties still encountered are touched on. Necessarily, in so small a space, there can be no question of writing a text book on even one of the three processes, but a fair introduction to the modern aspects of a great industry seems well presented.

The second section on rough-rolled plate is by Rudolf Simon, and extends over 60 or 70 pages. We have some misgivings about this section, as it seems, in quite extensive amounts, to be taken from Patent Specifications: what people propose to do when they file Patent applications, and what they really do as their experience accumulates, are two very different things. There are some things, probably many, in this section, which did not work out in practice, and have never been successfully used. The actual status of many of the inventions does not seem to be very thoroughly known to the author, but perhaps there is no-one to whom they are, at the present time, well known.

The third section, on polished plate, is by von Reis, and is some 60 pages long. This section is handled rather differently from the rest, and in some ways more satisfactorily. It is rather more technical in its treatment, scientific questions and problems are discussed, and extensive bibliographies of the literature are given.

The analyses of clays, the iron content of batch materials, power consumptions and the nature of the polishing operations are discussed.

The outlines of machine construction are fairly well dealt with, though some space is given to extinct layouts, and some more modern designs are passed over. Unfortunately, it is all but impossible to keep up to date in these matters, for between the time a thing is written and the time it is published, new designs are discarded, old ones resurrected, and still newer ones tested.

Taken by and large, however, this little volume, and especially von Reis' section, is an excellent introduction to the operations and technical problems of the Flat Glass Industry.—F. W. P.

EQUIPMENT AND SUPPLIES

ANNOUNCES GUNITE

Gunite Foundries Corporation, Rockford, Ill., has announced to the glass industry a new high-test air furnace iron for molds. Its special physical properties are said to be due to its analysis, method of melting and the foundry practice employed.

The advantages of Gunite for mold making are stated by its manufacturers as follows: "Gunite is produced at just the right hardness for satisfactory mold shop work. Machining is relatively easy and still the metal is dense enough at all points to take a brilliant polish. Exposed corners of molds and rings do not chip easily and, as a result, the glassware produced is freer from ridges at the operating points of the mold. In the mold shop the machine operator finds that the chips formed by the tool are cut instead of being crumbled off the casting. This results in smoother machined surface and shortens the final polishing operation. Another advantage lies in the excellent thermo-conductivity. Gunite is specially recommended for plungers, neck and finish rings, guides, press molds, blow molds, bottom plates and tips." F. W. Dixon, Jr. is in charge of sales to glass houses.

E. J. BRIDGES IN FLORIDA

E. J. Bridges, vice president of the Lynch Corporation, Anderson, Indiana, left February 23 with Mrs. Bridges for a two weeks vacation in Florida. Mr. Bridges is piloting his own plane, going and returning.

WELCOME "THE PIONEER"

The Pioneer is the name of a smart little newcomer to the world of publications. It is the good will ambassador of The Niagara Alkali Company, as its first issue states: "*The Pioneer* is planned to give practical, timely assistance and real entertainment to our thousands of friends and to cement the friendships that have grown up between the company and the many industries it serves. We shall endeavor to make *The Pioneer* more than a dry record of facts and information. Human interest will be the keynote of our policy. Whenever we have facts or information to give, we shall do so in as lively and entertaining a manner as possible. In this way we hope to be read and recommended and with the passing of time to be accepted as indispensable."

Give a hand of welcome to *The Pioneer*. It lives and breathes a vitality that is refreshing.

ELECTED FELDSPAR OFFICER

M. J. McHugh, Jr. was elected secretary and treasurer of Consolidated Feldspar Corporation and of Golding Sons Company, Trenton, New Jersey, by their respective Boards during their meeting the latter part of January.

Mr. McHugh comes to Consolidated Feldspar Corporation and Golding Sons Company well qualified be training and experience to assume the duties of his work. His appointment became effective February 1.

"HOMMELAYA"

The answer to every manufacturer's hope—a better product at a lower unit cost—has been discovered for the enameling industry in a new and basically different process. The process was developed through the joint efforts of Dr. J. E. Rosenberg, director of research for the O. Hommel Co., of Pittsburgh, and William J. Baldwin, incumbent of the industrial fellowship established by the company at Mellon Institute. It results in a new type of porcelain enamel product which will be known under the trade name of "Hommelaya". Patents have been granted or are pending in the United States and foreign countries.

According to Dr. Edward R. Weidlein, director of Mellon Institute, in addition to meeting or improving standards in all other respects, the Hommelaya process achieves a greater degree of opacity, and therefore depth of color, in two coatings and firings than are possible with three in present processes.

To the manufacturer the new process brings the following advantages: 1. A better product, less liable to craze or chip. 2. An important saving in cost of materials per unit. 3. A decrease of 33 1/3 per cent per unit in fuel and labor costs incidental to firing. 4. A 50 per cent increase in productive capacity of present kiln equipment. 5. A smaller number of rejected units due to the elimination of the hazard of the third firing.

The success of the laboratory experiments of Mellon Institute has been confirmed by use of the process under actual industrial conditions in several manufacturing plants.

AMER.CYANAMID APPOINTS ASSISTANT GENERAL SALES MANAGER

As a further step in the recent merger of the Structural Gypsum Corporation, American Powder Company, The Selden Company, and other former independent subsidiaries into the American Cyanamid & Chemical Corporation, Arthur J. Campbell has been appointed Assistant General Sales Manager of the Corporation. This step will serve to consolidate the activities of the newly created Divisions of the Corporation. Mr. Campbell at the same time will continue his duties as General Manager of the Structural Gypsum Division.

ED MILLER OFF TO FAR EAST

Edward Miller, former owner of the Miller Machine & Mold Works, left Columbus, Ohio, on February 18 for Vancouver, from which point he will take passage on the *S. S. Empress of Japan* for Honolulu. After a brief stay in Japan, he and Mrs. Miller will move on to Australia, visiting Sydney and Melbourne.

Ed, as he is known to many in the glass industry, expects now to be able to fulfill a promise made some years ago, and visit W. J. Smith and S. G. Garnsworthy of the Australian Glass Manufacturers Co., Ltd.

The Millers are scheduled to arrive in Los Angeles on April 20, and in New York (via the Panama Canal) on May 13, after which they will return to Columbus for another brief stay before settling down for the summer at their summer cottage on Sugar Island, Lake Erie.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	...	.29
Hydrochloric (HCl) 20° tanks ... Per	100 lb.	...	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	...	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 130 lb. carboy ext. Per	100 lb.	5.50	...
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	...
Tartaric	lb.	... Po. or Gr. Cry.	.23 .23½
Alcohol, denatured	gal.	...	...
Aluminum hydrate ($Al(OH)_3$)	lb.	.04-.04½	.04½-.05
Aluminum oxide (Al_2O_3)	lb.	.04	.05
Ammonium bicarbonate (f.o.b. works)	lb.	.05¼	...
(f.o.b. N. Y.)	lb.	...	.0571
Ammonium bifluoride (NH_4FHF)	lb.	...	.15
Ammonium nitrate (NH_4NO_3)	lb.	...	.08
Ammonia water (NH_4OH) 26° drums	lb.	...	.02¾
Antimonate of Sodium	lb.	...	.10½
Antimony oxide (Sb_2O_3)	lb.	...	.11¾
Antimony sulphide (Sb_2S_3)	lb.	...	.11
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03½	.04-.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	40.00	45.00
90% through 100 mesh	ton	37.00	...
Barium hydrate ($Ba(OH)_2$)	lb.	.05	.05½
Barium nitrate ($Ba(NO_3)_2$)	lb.	...	.08
Barium selenite ($BaSeO_3$)	lb.	...	1.50-1.75
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Bone ash	lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	...	...
Granulated	In bags, lb.	.02	.02¼-.02½
Powdered	In bags, lb.	.02½	.02½-.02¾
Boric acid (H_3BO_3) granulated	In bags, lb.	.04¼	.04½-.04¾
Cadmium sulphide (CdS)—	lb.	...	.70-.75
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Chromite	lb.	...	.0215
Cerium hydrate 100 lb. drums and 600 lb. barrels	lb.	...	.65
Chrome Oxide Green, 400 lb. bbls.	lb.	...	.215-.25
Cobalt oxide (Co_2O_3) In bbls.	lb	...	1.25
In 10 lb. tins	lb.	...	1.35
Copper oxide Red (Cu_2O)	lb.	...	.25
Black (CuO)	lb.	...	.15
Black prepared	lb.	...	.22
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.08½	.09
Synthetic (Artificial)	lb.	.08	.08½-.09
Epsom salts ($MgSO_4$) (imported) technical	Per 100 lb.	...	2.30
Feldspar— 20 mesh	ton	10.00-12.25	
40 mesh	ton	10.50-12.75	
Granular	ton	10.75-13.00	
Semi-granular	ton	10.00-12.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2 2½%) Bulk, carloads, f. o. b. mines	ton	25.23	...
In bags	ton	26.83	38.00-40.60
Formaldehyde, bbls.	lb.	...	.07
Graphite (C)	lb.	...	.04-.07
Iron oxide— Red (Fe_2O_3)	lb.	...	.0425
Black (Fe_3O_4)	lb.	.04½	...
Iron chromate	lb.	...	.035-.05
Kaolin (f. o. b. mine)	ton	8.00-9.00	...
English, lump, f. o. b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	...	.16
Lead oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.0605	...
In 5 Ton lots	lb.	...	.065
Less than 5 Tons	lb.	...	.07
Litharge (PbO) (New York Prices)	lb.	.0505	...
In 5 Ton lots	lb.	...	.055
Less than 5 Tons	lb.	...	.06
Lime— Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	...
Burnt (CaO) ground, in bulk	ton	7.00	...
Burnt, ground, in paper sacks	ton	9.00	...
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.25	2.25
Limestone ($CaCO_3$)	ton	1.75-2.50	...
Magnesium carbonate ($MgCO_3$)	lb.	.06	.08-.09
Magnesium sulphate (U.S.P.)	lb.	...	.03
Manganese, Black Oxide In Paper bags	ton	45.00	50.00
In Burlap bags	ton	46.50	51.50
In Casks	ton	48.00	53.00
Neodymidm oxalate, 50 lb. drums	lb.	...	5.00
Nickel oxide (Ni_2O_3), black	lb.	...	.35-.40
Nickel monoxide (NiO), green	lb.	...	.35-.40
Plaster of Paris, bags	ton	31.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)— Crystals	lb.	...	.08½
Powdered	lb.	...	.09½
Potassium carbonate	lb.	.0825	.0875
Calcined (K_2CO_3) 96-98%	lb.	.07⅞	.0875
Hydrated 80-85%	lb.	.06½	.0687
Potassium chromate (K_2CrO_4) 450 lb. bbls.	lb.	...	.16
Potassium hydrate (KOH) (caustic potash)	lb.	.06¼-.06½	.08-.08½
Potassium nitrate (KNO_3) (gran.)	lb.	...	.06-.06¼
Potassium permanganate ($KMnO_4$)	lb.	...	.19
Powder blue	lb.	...	.17-.18
Rare earth hydrate 100 lb. drums	lb.	...	.35
325 lb. barrels	lb.	...	.30
Rochelle salts, bbls.	lb.	...	.12½
Rouge	lb.	... Po. or Gr. Cry.	.13¼
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20 .25
Salt cake, glassmakers (Na_2SO_4)	ton	18.00	27.00
Selenium (Se)	lb.	...	2.00-2.10
Silver nitrate ($AgNO_3$) . (100 oz. bot.)	per oz.	...	.39
Soda ash (Na_2CO_3) dense, 58%— Bulk	Flat Per 100 lb.	1.10	...
In barrels	Per 100 lb.	1.50	...
In bags	Per 100 lb.	1.25	
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06½	.06½
Sodium chromate ($Na_2CrO_4\ 10H_2O$)	lb.	...	.08
Sodium fluosilicate (Na_2SiF_6)	lb.	.04¾	.05¼
Sodium hydrate ($NaOH$) (caustic soda) Flake	Per 100 lb.	3.00	...
Solid	Per 100 lb.	2.60	...
Sodium nitrate ($NaNO_3$) — Refined (gran.) in bbls.	Per 100 lb.	...	2.00-2.25
95% and 97% Bulk	Per 100 lb.	1.175	...
200 lb bags		1.24	1.29
100 lb. bags		1.275	1.325
Sodium selenite (Na_2SeO_3)	lb.	..	1.80-2.00
Sodium uranate (Na_2UO_4) Orange	lb.	...	1.50-1.55
Yellow	lb.	...	1.50-1.55
Sodium uranyl carbonate	lb.	...	.80-.90
Sulphur (S)— Flowers, in bbls.	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Tin chloride ($SnCl_2$) (crystals) in bbls.	lb.	...	.36½
Tin oxide (SnO_2) in bbls.	lb.	...	.54-.58
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	...	3.00
Yellow orange	lb.	...	1.60
Zinc oxide (ZnO) American process, Bags	lb.	.0575	.06
White Seal, 150 lb. bbls.	lb.	.10½	.10¾
Green Seal bags	lb.	.09¾	.09¾
Red Seal, bags	lb.	.08¾	.08¾
Zircon Granular (Milled .005-.02c higher)		.07	.67½-.08
Crude, Gran. (Milled .005-.02c higher)		.03½	.04-.07

SUMMARY OF GLASS DIVISION PAPERS

(*Continued from page 72*)

test practice was to run the test at the same pressure the bottles meet in practice but with a doubled time period. In some tests, however, the pressure and time period was considerably greater than the actual conditions this type of glass meets in practice. In most cases the breakdown of the inner surface of the bottle was measured by its appearance. It was found that the inner glass surface in back of places in contact with paper, string or other glass surfaces usually showed considerably less breakdown than the rest of the surface. This was thought to be due to differences in the rates of conduction and evaporation of moisture on the inner walls of the bottle caused by different rates of heating and cooling of the glass at the points of contact. The size and shape of the bottles also gave varying surface breakdown appearances due to glass thickness, drainage or collection of condensed water, movement of the steam over the surface and other variables.

The effect of the age (weathering) of the bottles was also illustrated. Old bottles always gave better looking inner surfaces than new bottles. This was due to the fact that the bottles are always washed out before testing. In the case of the old bottles the products of weathering are thereby removed and the surface is less alkaline than the surface of a new bottle.

It was noticed that in certain commercial practices where autoclaving of the bottle was employed, cotton plugs placed loosely in the neck of the bottle prevented surface breakdown. This was checked by laboratory tests and led to tests made with dry steam. A special apparatus for producing dry steam was developed and tests of bottles under these conditions were made. These tests showed that the action of saturated steam on glass is apparently an action of superheated water. Filtration of the steam caused a decrease in the surface breakdown due to the removal of the entrained water, while the use of dry steam resulted in no apparent surface breakdown.

The discussion following the presentation of this paper brought out that when the bottles are filled entirely with water and tested in the autoclave the action is purely the action of water at high temperature; that the effect of pressure can be ignored; and that many of the discrepancies noted by the author can be attributed to various mechanical defects in using steam as a reacting material.

9. Investigations of Opalescent Glasses: Silicon, Sodium, Calcium, Aluminum, Oxygen, Fluorine Series

By Henry H. Blau and Victor Hicks, Macbeth-Evans Glass Co., Charleroi, Pa., and Alexander Silverman, Univ. of Pittsburgh, Pittsburgh, Pa.

This paper is an extension of the previous work by the authors on this subject. The method used in this investigation was essentially the same as that of the previous investigation except that Al_2O_3 replaced CaO in the glasses used. From the results obtained it was concluded that fluorine may be evolved from the glass in several ways. It may be evolved in part as the fluoride of sodium, aluminum and calcium or in part in some form not associated conventionally with these elements or silica (probably as HF). When the fluorine content is high it may be evolved in part as SiF_4. It was also shown that, while the presence of alumina in glasses containing both calcium and alumina seemed to reduce the fluorine loss, the resulting glasses did not necessarily have greater opacity. A comparison of the vapor pressures of Na, Al, and Ca at the melting temperature showed in general the same relative magnitude as their losses from the glass.

X-ray studies, even on heat-treated glasses showing well defined diffraction lines, gave no indication of the function of fluorides as causes of opalescence.

10. The Effect of Temperature Treatment on Glass to Metal Seals

By J. T. Littleton, Corning Glass Works, Corning, N. Y.

It has been known for some time that glass cooled from temperatures well above the annealing temperature contracts at a rate depending upon its cooling rate and the temperature from which its cooling begins. Expansion measurements taken on the glass duing later heating do not follow the original contraction curve. A photoelastic method is described which gives information on how the contraction of the glass is affected by these temperature conditions. The observations are of particular interest when applied to glass-metal seals, inasmuch as glass free from strain to metal seals can only be obtained by the use of the proper heat-treatment which is characteristic of a given combination. The use of this photoelastic method on a series of seals with varied thermal histories and the determination of the best heat-treatment was given.

11. The Measurement of Strains in Glass Rods

By A. W. Hull, General Electric Company, Schenectady, N. Y.

Mathematic analysis has shown that when a symmetrically strained glass rod is viewed in polarized light at right angles to its axis, the only phase displacements produced are those due to the axial components of stress. This method has been applied to the analysis of stresses in glass metal seals. It is also applicable to the quantitative determination of annealing rates.

12. X-Ray Diffraction Study of the Structure of Soda-Silica Glasses

By B. E. Warren, Massachusetts Institute of Technology, Cambridge, Mass.

X-ray diffraction patterns were made on a graded series of soda-silica glasses in which the soda content varied from 0 to 46 per cent. In this series the change of pattern was perfectly continuous and the patterns gave no evidence of compound formation. It was shown that the patterns can be quantitatively interpreted in terms of a random network structure and a rather complicated mathematical expression was given which was used by the author in developing the patterns in this manner.

The structure of this net work was illustrated and showed that each silicon is tetrahedrally surrounded by four oxygens and, that part of the oxygens are bonded to two silicons and the others to one silicon and one or two sodiums.

13. Infra-Red Transmission of Glass

By E. D. Tillyer and T. M. Gunn, American Optical Co., Southbridge, Mass

Dr. Tillyer first presented a brief historical review of the work of Crookes and others on the development of glasses with specified light and heat transmissions. It was shown that Crookes was the first to recognize and use cerium for absorbing the ultra-violet region, and ferrous iron for the infra-red absorption.

The authors' work was limited to the infra-red region of the spectrum and a diagrammatical description of the apparatus and the method used was presented. Both can be briefly summarized as follows: the heat source (a radiant heat element such as is used in radiant electric household heaters) was focused on a mirror and reflected to a prism connected with a graduated scale. From the prism the heat band being measured was received by another mirror and reflected to a delicate thermocouple connected to a galvanometer to measure the emf developed. In measuring the transmission of a glass sample the emf of the system is first measured without the glass sample and then with the glass sample in the path of the heat source. The difference in the two emfs is a measure of the glass transmission of the heat band coming through the prism.

A series of transmission curves of various glasses in the region from 0.7 to 5.0 microns were then shown. One of the most interesting points developed by these curves, aside from the lack of effect of many of the glass materials in this region, was the influence of the presence of B_2O_3 which caused a marked decrease at the 3.5 micron region in the transmission of glasses containing this oxide. A curve was also given of the infra-red transmission of water which also showed a dip in the curve at this point. Dr. Tillyer was in doubt as to whether the presence of water in the glass or the B_2O_3 could be causing this marked absorption in this region. These various curves also showed the great value of ferrous iron for absorbing the infra-red portion of the spectrum.

The relation of the infra-red transmission of a glass and its melting characteristics was then shown by a series of curves. A radiant energy curve of a black body at glass furnace temperatures was given along with the infra-red transmissions of flint glass, blue cobalt glass and a ferrous iron glass. The flint glass had a high infra-red transmission while the blue glass had a much lower transmission of the hill and valley type. The iron glass was marked by a very low transmission throughout the entire region. The flint glass would therefore absorb the heat energy and transmit it to a considerable depth while the blue and green glass would absorb and transmit it to only a very short depth. It is possible, therefore, to determine the energy absorbed by the surface layers of the glass from the radiant heat in the furnace from the infra-red trans-

mission of the glass, if the transmission curve of the glass does not shift too greatly with increased temperature.

The paper was concluded with the presentation of some preliminary data on the determination of the iron content of glasses from their infra-red transmissions. The method seems to have distinct possibilities inasmuch as the equipment is not excessively expensive and the time required is very short.

The presentation of this paper marked the first appearance of Dr. Tillyer as a speaker before the Glass Division members. His interesting presentation caused many of those present to express the desire that he speak at future meetings.

14. Strength of Glass under Sustained Loading

By F. W. Preston, Butler, Pa.

In the absence of Dr. Preston the paper was read by Mr. Bowes.

The work of Phillips, Spencer, McKee, Borchard and others on the "elastic after-working" of glass was reviewed and examples of the measurement of "creep" given.

In the author's laboratory tests on the decrease of strength with continual loading have been made on samples of plate glass, Fourcault drawn window glass and bottles. In the case of plate glass the strength declined from 11,900 lbs. per sq. in. when a 5 sec. period was used to 5,420 lbs. per sq. in. when the period was four hours. The window glass declined in strength from 13,150 lbs. per sq. in. (5 sec.) to 7,950 lbs. per sq. in. (30 min.) In the case of bottles the strength did not decline so fast with time. As this is unusual it is thought that differences in composition may explain the more rapid decline of the plate and window glass.

It was also pointed out that tests of long duration are particularly important because it is very far from clear whether the strength declines to some finite limit or whether it actually goes to zero or a very long test. It should also be known at least what per cent of the strength as ordinarily measured is left at the end of a couple of years' testing.

15. The Effect of Variable Viscosity Upon Stress Release in Glass at a Constant Temperature

By H. R. Lillie, Corning Glass Works, Corning, N. Y.

An effort is made to demonstrate experimentally a relation between the rate of release of strain and the rate of change of viscosity for annealing at constant temperature. A new expression free from these objections and taking into account the variation of viscosity with time is shown correctly to represent observed annealing rates under a larger variety of conditions than those to which the Adams-Williamson law can be applied.

16. The Peate Telescope Mirror of 1895

By F. W. Preston, Butler, Pa.

In the absence of Dr. Preston a brief summary of this paper was given by Dr. Hostetter.

The first big telescope mirror cast in the United States was made by the Standard Plate Company at Butler, Pa., in 1895 and was figured by John Peate, Greenville, Pa., between 1895 and 1898. Peate at the time* was a retired minister and was interested in astronomy. A brief history of the undertaking was given and illustrated.

17. The History and Some Measurements of the Peate Disk

By G. W. Morey, Geophysical Laboratory, Washington, D. C.

Dr. Morey gave a brief description of the method of supporting the disk and some of the difficulties encountered in measuring its properties. Its very unsymmetrical and excessive strain figure was shown. Other measurements will be taken in the spring when more uniform temperatures may be encountered.

18. Some Engineering Problems Connected with the Manufacture of a 200-Inch Telescope Disk

By George V. McCauley, Corning Glass Works, Corning, N. Y.

Dr. McCauley is to be congratulated upon the excellence of this paper which without a doubt proved to be the "pièce de résistance" of the Glass Division papers. Unfortunately it does not readily lend itself to abstracting as it is a complete photographic record of a difficult and long job which was well done. In brief, however, the processes of melting, ladling, casting, annealing and crating were explained from an engineering viewpoint. Departures from usual practice in these processes brought about by the use of existing equipment, a special glass; and commercially obtainable material were discussed.

*Mr. Peate was born in 1820, making his age 75 or 78 years. See also news item and illustration on page 83.—Ed.

19. Properties of Refractory Brick Suitable for Use in Glass Furnace Upper Structure

By W. L. Fabianic, Owens-Illinois Glass Co., Atlon, Ill.

A practical investigation was conducted on the selection of those refractories most suitable for use in glass furnace port jambs, port sills, port floors, baffles, port nozzle sidewalls, port sidewalls proper, and top checker courses. These refractories are exposed to the destroying action of a viscous high-temperature basic slag and batch dust of a given composition. Over one hundred various brands of brick were tested, ranging in composition from a first grade fire brick to super-refractories of the 80 per cent alumina class. The mechanical, chemical, physical, and mineralogical properties of these brick were studied. The results of the test determinations were checked by making actual service installations in operating furnaces. The performance of the refractories in these installations after ten months of service verified the test results to a remarkable degree. The mineralogical relationship of the minerals in the refractory as received was found to be of more importance than chemical or physical properties. A tentative method of determining the suitability of a brick for actual service by combining petrographic inspection with physical properties is suggested.

20. Water Jackets for Glassmelting Tanks

By L. T. Sherwood, Pennsylvania Wire Glass Co., Dunbar, Pa.

Although the use of water jackets for glassmelting tanks has been commonly spoken of as "water cooling" with a view to preservation of the clay blocks, a materially different concept was explained in this paper. According to this concept, the water jackets are simply a reliable reinforcement instead of a preservative comparable to air cooling, as the use of water jackets will insure continuous operation when the blocks begin to wear thin. If a break occurs the glass will freeze against the jacket and the tank may be safely operated for some time. As it is now recognized that deterioration of the block is rapid until the thickness is reduced enough to promote a material cooling of the glass at the interface, thinner blocks may be used along with water jackets.

The cost of operating water jackets depends entirely upon the individual circumstances. If water is cheap the cost of operating is low. Where water cost is high, cooling and reuse of the water by spray ponds may be the solution. As far as fuel costs are concerned there is no evidence that water cooling increases the fuel cost, as air cooling does, until the blocks are so thin that the glass is actually in contact with the jacket.

21. Investigation of the Use of Magnesium Aluminate (Spinel) for Glassmelting Containers

By C. W. Parmelee and K. C. Lyon, University of Illinois, Urbana, Ill.

Magnesia spinel being a refractory compound of an alkaline earth and a neutral oxide, theoretically should tend to stability against the effects of such oxides. A review of the literature on this subject was given.

Crucibles were then formed from spinel raw materials and commercial spinel grains, with and without admixtures of other chemicals. Bottle glass was melted in these and the behavior compared with similar containers made from fireclay grog and mullite. The tests consisted of heating bottle glass in the crucibles at 1400° C for four hours and noting the appearance of the crucibles after the treatment. In the case of the spinel crucibles the glass seeped through the crucibles. In general, the results indicated that, under the conditions used, magnesia spinel is not suited for glass refractories. The solution of the problem may be casting the materials in the molten state as in cast mullite blocks.

22. Kyanite in Crucibles for Melting Glass

By S. R. Scholes, Dept. of Ceramics, N. Y. State College of Ceramics, Alfred, N. Y.

Excellent crucibles for experimental glassmaking have been made from calcined kyanite (60-mesh) 65 and plastic fire clay 35 by slip-casting in gypsum molds. The crucibles were fired at 1200° C before using. Details are given of sources of materials, procedure, and behavior in service.

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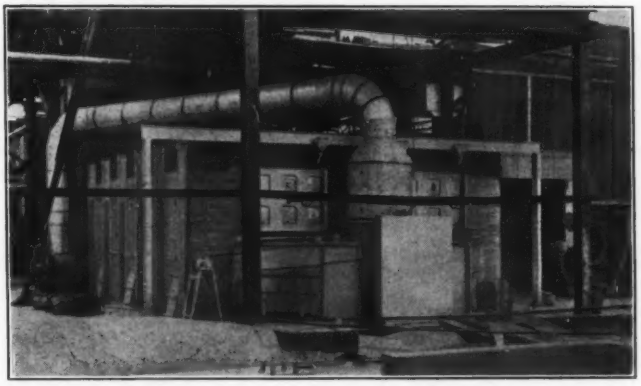

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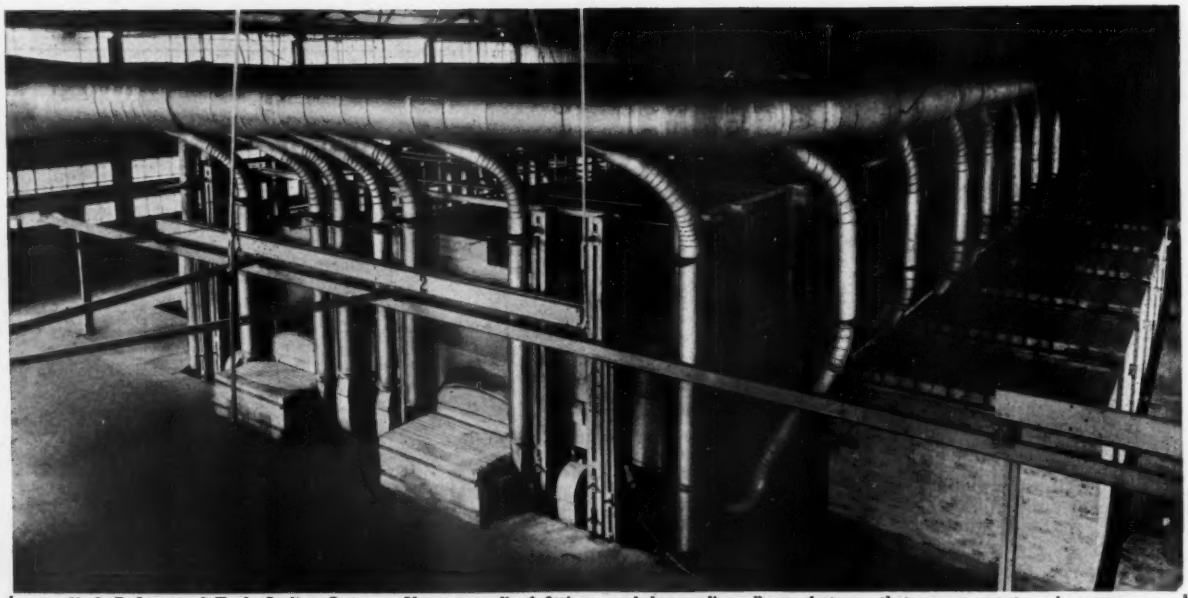
CINCINNATI, OHIO



K & B Improved Tank Cooling System. Note streamlined fittings and long-radius elbows—features that assure greater air pressure with less power.

Efficient Cooling by K & B Insures *Double Savings!*

KIRK & BLUM Blower Systems

K & B Tank Block Cooling Systems, efficiently designed with streamlined piping and fittings, assure double savings. First, by reducing power costs; second, by increasing the life of the tank and eliminating frequent repairs.
Without obligation, our engineers will analyze your cooling problem and recommend where and how savings may be made. Write

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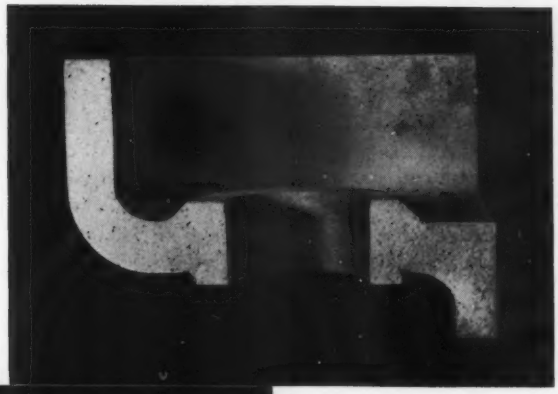
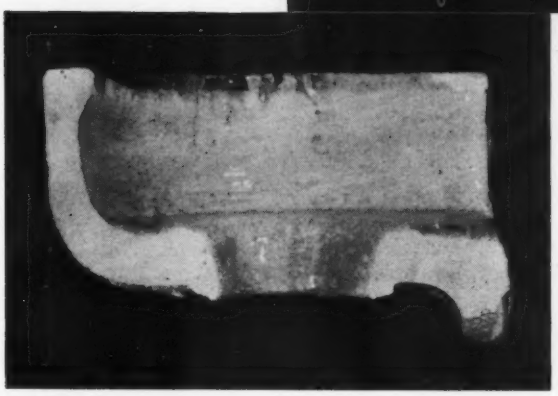
Pittsburgh Representative: The Bushnell Machinery Co., 1501 Grant Bldg.
Louisville Representative: Liberty Blow Pipe Co., Inc., 325 Roland Street

RESULTS



Cross-section of unused P. B. Sillimanite feeder spout



Cross-section of P. B. Sillimanite feeder spout after 15 months of service. Note how well defined the opening remains.

15 MONTHS service and still good for several months more when removed because of a tank repair! On the same tank clay feeder spouts had lasted only 3 to 4 months.

A trial will convince you that P. B. SILLIMANITE feeder parts are economical because:

1. Their long life means fewer replacements, (3 to 7 times the life of clay feeder parts).
2. Their low iron content removes the danger of streaked ware.
3. Their resistance to glass attack eliminates them as a source of stones.

TAYLOR P B SILLIMANITE

All P. B. Sillimanite made by The Chas. Taylor Sons Co. bears this trade-mark

THE CHAS. TAYLOR SONS CO.

CINCINNATI, OHIO

GLASS INDUSTRY

Devoted to Glass Technology, Engineering, Materials and Glass Factory Equipment and Operation

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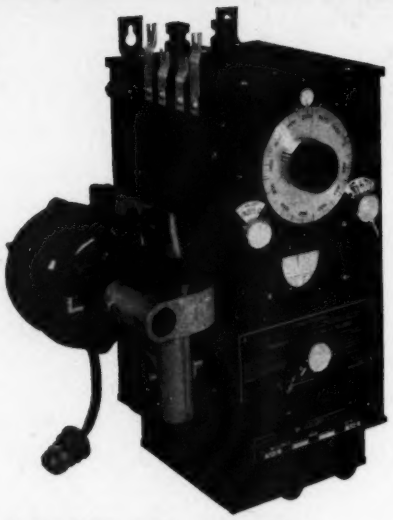
UNIQUE



BECAUSE IT HAS—

1. Fixed Slide Wire Contact

In the Foxboro design of fixed setting of the slide wire the galvanometer deflects in one direction (the right) when the temperature is below the control point and in the other (the left) when above the control point. This directional relation makes it possible to apply the temperature detecting device to the galvanometer and results in much greater sensitivity of control action.

2. Knife-Edge Detection

Since in this design the galvanometer deflection is independent of the calibrated scale, the galvanometer has been built to give maximum deflection for any temperature change. The slightest change in temperature gives enough deflection so that the knife-edge detecting mechanism will operate the Controller to correct the temperature.

RESULT—

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For good control, high sensitivity (i.e., the ability to operate the valve on minute changes in temperature) is essential. The unique design of the Foxboro Pyrometer Controller gives it ***extreme sensitivity*** and results in very close control. There are many other important features that you should know about this Potentiometer Controller. For instance: It has an automatic cold junction compensator and a safety cut-out that puts the system on minimum heat in the event of a thermocouple burn-out or other damage. Write today for Bulletin No. 182 which will give you the whole story—no obligation of course.

THE FOXBORO COMPANY
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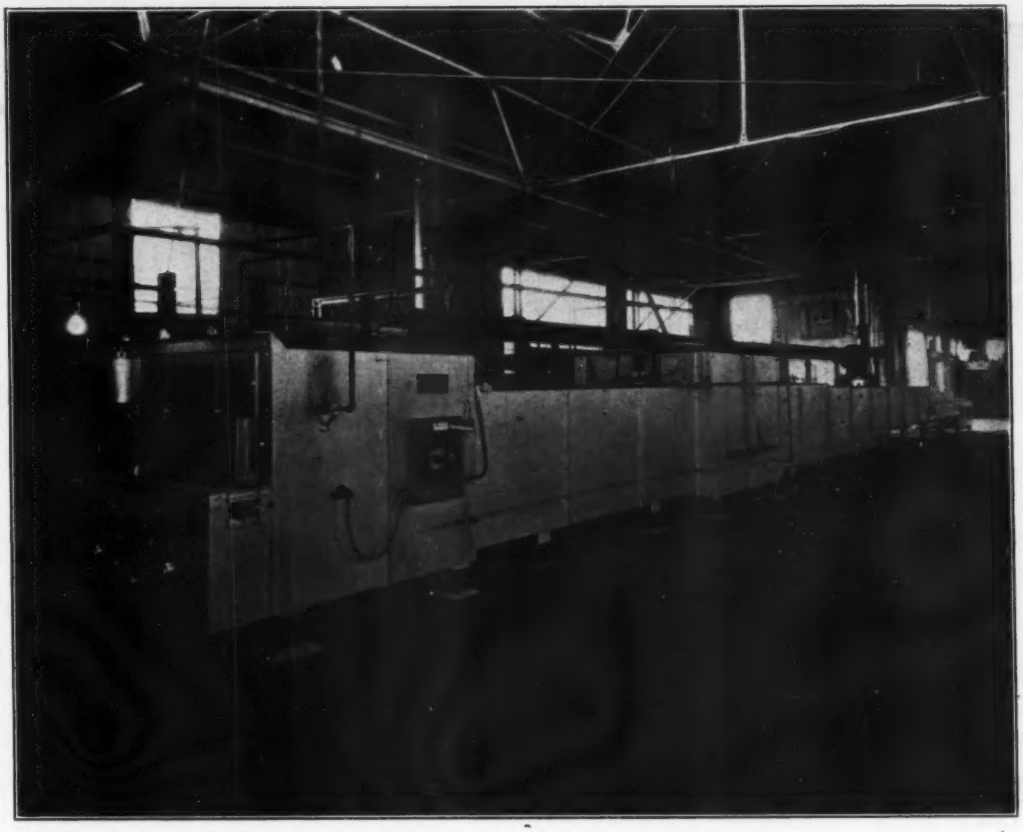

WHY CONSIDER A ONE FUEL LEHR?

Twenty years of specilization in the glass industry has taught the need of flexibility in lehrs. Flexibility in speed—flexibility in control and flexibility of fuels—all are of equal importance. The absence of one is a backward step.

When you buy a lehr you expect it to last for ten to twenty years—but will you have natural gas at a reasonable price then? Will you have it at all—or will history repeat and force you to an unnecessary investment in new annealing equipment because you neglected to consider a multi-fuel lehr?

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– wide mouth – large or small order

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